PARTS OF THE ORIGINAL DOCUMENT

ARE OF POOR REPRODUCTIVE QUALITY

CERTAINES PARTIES DU DOCUMENT ORIGINAL

SONT DE PIÈTRE QUALITÉ DE REPRODUCTION

Atomic Energy Control Board
P.O. Box 1046
Ottawa, Canada
K1P 5S9

Commission de contrôle de l'énergie atomique
C.P. 1046
Ottawa, Canada
K1P 5S9

INFO-0239

EVALUATION OF METHODS TO CALIBRATE RADIATION SURVEY METERS

by

R.C. Robinson and N.D. Arbeau
Atlantic Nuclear Services Ltd.

A research report prepared for the
Atomic Energy Control Board
Ottawa, Canada

Project Number 86.6.7

April 30, 1987

Canada

Research report

EVALUATION OF METHODS TO CALIBRATE RADIATION SURVEY METERS

A research project prepared by R.C. Robinson and N.D. Arbeau, principal investigators for Atlantic Nuclear Services Ltd., under contract to the Atomic Energy Control Board

---

ABSTRACT

Calibration requirements for radiation survey meters used in industrial radiography have been reviewed. Information obtained from a literature search, discussions with CSLD inspectors and firms performing calibrations has been considered. Based on this review a set of minimum calibration requirements was generated which, when met, will determine that the survey meter is suited for measurements described in the current AEC Regulations that apply to industrial radiography equipment. These requirements are presented in this report and may be used as guidelines for evaluating calibration methods proposed or in use in industry.

RÉSUMÉ

Les critères d'étalonnage des radiamètres utilisés en gammagraphie industrielle ont été examinés, à la lumière des renseignements contenus dans la documentation existante, ainsi que de discussions avec des sociétés d'étalonnage et des inspecteurs de la Division des contrôles et des laboratoires. Par suite de cet examen, on a établi une série de critères d'étalonnage minimaux à partir desquels il sera possible de déterminer si tel ou tel radiamètre est propre à servir aux mesures prévues par le Règlement CEA actuel dans le cas de l'équipement de gammagraphie industrielle. Le présent rapport traite de ces critères qui peuvent servir de lignes directrices pour évaluer les méthodes d'étalonnage proposées ou déjà utilisées par les secteurs industriels.

DISCLAIMER

Any reference to commercial instrumentation is solely for illustrative purposes and is in no way an endorsement of one brand of equipment over any other.

The Atomic Energy Control Board is not responsible for the accuracy of the statements made or opinions expressed in this publication and neither the Board nor the author assumes liability with respect to any damage or loss incurred as a result of the use made of the information contained in this publication.

TABLE OF CONTENTS

1.0 Introduction

2.0 Radiation Survey Meter Calibration

2.1 General Methodology
2.2 Characterization of Methods in Use

2.2.1 Calibration in Radiation Fields from a Known Source
2.2.2 Calibration by Substitution with a Standard Meter
2.2.3 Similarity Method

2.3 Characterization of Equipment Configurations

2.3.1 Beam Calibrators
2.3.2 Shielded Calibration Rig
2.3.3 Calibration Wells or Chimney

2.4 Factors Affecting the Adequacy of Calibration Methods

2.4.1 Uncertainty in Calibration Source Strength
2.4.2 Required Calibration Source Strength
2.4.3 Accuracy of Calibration Apparatus

2.4.3.1 Measurement of Distance
2.4.3.2 Placement of the Meter

2.4.4 Effect of Radiation Attenuation and Scatter

2.4.4.1 Use of Attenuators
2.4.4.2 Effects of Scattering

2.4.5 Elimination of Other Sources of Error

2.4.5.1 Viewing and Manipulation of Instrument during Calibration
2.4.5.2 Calibrating Over Different Ranges
2.4.5.3 Possible Environmental Effects
2.4.5.4 Electronics
2.4.5.5 Energy Response

2.4.6 Requirements for Precalibration Checks

2.4.7 Requirements for Calibration Documentation

2.5 Quantitative Analysis of Uncertainties in Calibration Methods

2.5.1 Uncertainties in the Known Source Method
2.5.2 Uncertainties in the Substitution Method

2.5.3 Inherent Uncertainty and the Effect on Calibration

3.0 Calibration Methods Currently in Use in Industrial Radiography

3.1 Survey of Methods in Use
3.2 Present AEC Regulations Requirements
3.3 Present Requirements in U.S.A.

4.0 Summary of Calibration Method Requirements

5.0 An Optimal Method

6.0 Summary

7.0 References

8.0 Bibliography

Appendix A - Present AEC Regulations with Respect to Radiography

Appendix B - Derivation of Minimum Source Requirement and Positional Accuracy

Appendix C - Excerpts of 10CFR 34 - Licenses for Radiography and Radiation Safety

Tables

Table 1 Decay Correction Factors for Activity and Dose Rate.

Table 2 Calculated Dose Rate with Distance From 37 GBq (1 Ci) Source Activity.

Table 3 Summary of Calibration Techniques of Surveyed Firms

Figures

Figure 1 Example of a Beam Calibrator

Figure 2 Example of a Shielded Calibration Rig

Figure 3 Example of a Calibration Well or Chimney

Figure 4 Sample Exposure Rate Versus Distance Curve of a 370 GBq (10 Ci) Source

Figure 5 Example of a Meter Scale

Figure 6 Sample Calibration Data Sheet

Figure 7 Sample Calibration Sticker

1.0 INTRODUCTION

This report identifies and assesses methods for calibrating radiation survey meters used in the radiography industry to evaluate fields from Ir-192 and Co-60. The terms of reference for the assessment are the existing AEC Regulations (attached as Appendix A). This report is intended to be used as a technical reference document for evaluating calibration methods and procedures in use by Canadian Industrial Radiography Firms.

Information for this study was compiled from:

(a) a review of methods given in the open literature.
(b) discussion with Compliance Service and Laboratories Division (CSLD) supervisors and inspectors.
(c) discussion with radiography firms and/or service companies which provide calibration services.

Section 2.0 of this report reviews calibration methodology, general requirements for sound methods and practices, and factors affecting the adequacy of different methods. This includes discussions of the merits and limitation of various methods found to be in use in industry. Also a quantitative analysis of the uncertainties associated with various methods is given.

In Section 3.0 a summary of methods currently in use in Industry is given. The current AEC regulations with regard to radiation survey meter calibration are summarized and discussed.

Based on the considerations given in Section 2.0, and the requirements of the AEC regulations which are summarized in Section 3.0, a list of requirements for acceptable calibration methods is given in Section 4.0. This requirements list is intended to be used as a reference guideline for evaluating any given procedure.

In Section 5.0 an optimal method is presented along with a discussion of ways to improve presently inadequate methods found in the survey of industry.

As part of the study a general literature search was conducted on radiation survey meter calibration. In Section 8.0 a Bibliography of all citations found in the search is given.

Units and measurements used throughout the document conform to SI format with the exception of the unit for exposure,

the Roentgen. As the older units are still found in manuals and descriptive literature concerning imported sources and as many of the workers in Radiography received training in the older units, these are given in parentheses after the SI units.

2.0 RADIATION SURVEY METER CALIBRATION

Radiation survey meters detect ionizing radiation emitted from radioactive sources. Detector tubes used in most survey meters consist of gas filled chambers across which a high potential voltage is applied. Incident radiation ionizes the gas in the chamber creating an electronic pulse. The meter electronics detect the pulse rate and convert it electronically to dose rate which is displayed in an analog or digital fashion.

Calibration of Radiography Survey meters ensures that the instruments, when used to assess the radiation fields and the radiation hazards associated with Radiography sources, are providing accurate and relevant information.

The process of calibration should satisfy the requirements of a quality assurance routine, defined as: All those planned and systematic actions necessary to provide adequate confidence that an item or a facility will perform satisfactorily in service.

Calibration requires that the survey meter be exposed under standard conditions in known radiation fields, so that its response across the meter scale range or ranges, can be determined and a measure of its accuracy and precision of response obtained.

The accuracy of the meter response, relative to predetermined criteria, will indicate whether or not the particular meter is suitable for use in measuring radiation fields.

Calibration may be performed in several ways, by reference to different Standards, which may be ranked as:

A Primary Standard

B Transfer Standard

C Secondary Standard

D Field Instruments

A. Primary Standards

In Canada Primary Standards are high quality devices which measure radiation fields with a certified high degree of accuracy.

These devices are usually extrapolation chambers, free air chambers or calorimeters. They are set up in controlled laboratory conditions (such as NRC in Ottawa) and are maintained over time verifiably accurate.

Primary Standards are not radioactive sources since many factors can change the level of radiation emitted by sources which cannot be detected except by reference with another Primary Standard.

B. Transfer Standards

Transfer Standards are accurate stable devices which are calibrated by comparison with Primary Standards. These Transfer Standards can then be used to measure radiation fields with a high degree of accuracy and confidence over a period of time. The Transfer Standards device is portable and therefore can be used to transfer the accuracy of Primary Standards to other locations outside the Primary Standards Laboratories.

C. Secondary Standards

Secondary Standards are either sources or measuring devices which have been calibrated by comparison with either a Primary Standard or a Transfer Standard at one period in time to a given uncertainty. Sources used in the known source calibration method (see Section 2.2.1) are Secondary Standards.

The Secondary Standards accuracy has to be verified periodically by either direct comparison with a Primary Standard or Transfer Standard or by indirect comparisons with devices that measure the consistency of the Secondary Standard measurement (film badges, dosimeters, etc.).

D. Field Instruments

These are the survey instruments used to take measurements of radiation fields associated with Radiography source. Calibration of the response of these instruments should be by reference to a Primary or Secondary Standard.

2.1 GENERAL METHODOLOGY

The calibration of a radiation survey meter involves the placement of the meter in a known radiation field and ensuring that the reading on the meter reflects to within an acceptable tolerance the dose/dose rate due to the field. Survey meters are required to be calibrated over a wide range of dose/dose rates. Therefore, a calibration method also involves adjustment of the dose rate due to the calibrating radiation field in known fixed amounts, and ensuring the meter reads within the required tolerance.

As such any acceptable calibration procedure is composed of the following essential components:

(a) A calibrating radiation field with a dose rate that is known, or can be measured to within an acceptable standard, and with a level that can be adjusted to cover the calibration range required.

(b) A method of fixing and reading the survey meter to be calibrated in the known field, in an accurate and reproducible manner.

(c) A method to adjust the calibrating dose rate at the meter in a known and reproducible fashion, over a range required by regulations and or by intended use.

2.2 CHARACTERIZATION OF METHODS IN USE

Different methods can be used to provide the essential components discussed in Section 2.1, with varying degrees of success and accuracy. From a review of literature on the topic, discussions with firms performing or offering calibration services, and discussions with CSLD Inspectors, three general categories of methods have been delineated. These methods all assume a broad beam of source radiation is used in the calibration.

2.2.1 Calibration to a Radiation Field From a Known Source

In this method a known radiation source is used to provide a radiation field for calibrating purposes. The dose rate is determined from the known source strength and the placement of the meter relative to the source. The dose rate is adjusted by either changing the distance between the source and the meter or by placement of radiation attenuators between the meter and the source.

2.2.2 Calibration by Substitution With a Transfer Standard

In the substitution method a calibrating radiation field is produced by a source, however, the dose rate of the field is not determined from the strength of the source but rather from measurements with an accurate meter (Transfer Standard). The Transfer Standard meter is used to determine the field dose rate for various combinations of source-meter distance and attenuators. The survey meter to be calibrated is then substituted for the Transfer Standard meter and readings compared to the Transfer Standard meter readings for the same combination of source-meter distance and attenuators.

2.2.3 The Similarity Method

The Similarity Method is essentially the same as the Known Source Method described in 2.2.1 except that the high range radiation field calibration is accomplished by comparison of dose rates from two sources differing in activity by known fixed amounts. Because of the inherent inaccuracy of this method, it is not recommended and is only mentioned here for completeness.

2.3 CHARACTERIZATION OF EQUIPMENT CONFIGURATIONS

Equipment configurations used in calibration of survey meters can be divided loosely into three different categories. The following sections describe the general attributes of each category.

2.3.1 Beam Calibrators

A point source provides a broad beam of radiation. The meter to be calibrated is placed on a jig, or mounting platform directly within the beam. The field is varied by movement of the jig along a track or slide. Usually mounted on the track or slide is an accurate scale for distance measurement. An example of a Beam Calibrator is shown pictorially in Figure 1.

2.3.2 Shielded Calibration Rig

In this configuration a shielded source or a source with a shielded port is used. Attenuators and moveable meter mounting tables are remotely manipulated. The entire rig is surrounded by a radiation shield to reduce personnel exposure to radiation and also to reduce unwanted background effects. These types of devices are compact and portable. An example of this type of rig is shown pictorially in Figure 2.

2.3.3 Calibration Wells or Chimney

This type of calibrator consists of a tunnel-like shielded chimney or well. The meters to be calibrated are fixed in place at the top of the well or chimney for easy viewing. The source is located at the bottom of the well but can be moved vertically along the well. Attenuators are also used to vary the field at the meter. In Figure 3 a pictorial representation of this type of calibrator is given.

2.4 FACTORS AFFECTING THE ADEQUACY OF CALIBRATION METHODS

The following sections consider the various components of most calibration methods and the equipment used and the factors affecting their adequacy.

2.4.1 Uncertainty in the Calibration Source Strength

For calibration using radiation dose rates from a known radiation source it is important that the strength of the source be certified at one point in time to a Primary Standard within a known uncertainty. Also, since the strength of a radioactive source will decay with time, accurate decay calculations are necessary on a routine basis to update the dose rate from the source.

The activity of sources used in the Known Source calibration should be traceable to either the Primary Standards of the U.S. National Bureau of Standards (NBS) or the Canadian National Research Council (NRC). Accuracy of source strength should be certified to be traceable to the Primary Standard within an uncertainty of $\pm$ 5% or less. More accurate sources are available (uncertainty of $\pm$ 2% or so) but are generally more expensive and not required for this type of work.

Periodically, sources used in the Known Source Method should be checked for damage or other physical changes which might change the level of the radiation field emitted. This check could be by calibration with a Transfer Standard or, if not feasible, a consistency check with film badge or other dosimeters could be done. The check is to ensure the emitted radiation from the source is varying as expected in an exponential fashion.

If calibrations are being done with Cs-137, decay correction of dose rates should be done as a minimum at least every six months to ensure a source strength accuracy of $\pm$ 1.0 % or less. A Co-60 source requires a more frequent decay

corrections of at least once every two months for the same accuracy level. More frequent calculations would assure greater accuracy. Optimally, a decay calculation could be performed at the time of each calibration as part of the procedure.

2.4.2 Required Calibrating Source Strength

As will be discussed in Section 3.2, the current AEC regulation requires that a survey meter be calibrated in the 10-100 mGy/h (1-10 R/hr range). If the Known Source Method is used this would necessitate the ability to calibrate accurately in a field of at least two-thirds of the 10-100 mGy/h (1-10 R/hr) range or at 70 mGy/h (7 R/hr). Figure 4 shows a typical exposure rate vs. distance-from-source curve for a 370 GBq (10 Ci) source. This figure shows clearly the $1/r^2$ point source dependence assumed in the calculation. Table 2 shows the change in calculated dose rate with distance from a 37 GBq (1 Ci) source.

From consideration of the requirement to calibrate in the 10-100 mGy/h (1-10 R/hr) range it has been determined that at least a 37.0 GBq (1 Ci) source is required. The rationale for this requirement is given in Appendix B. If the upper end of the required range was reduced a smaller calibrating source would suffice.

2.4.3 Accuracy of Calibration Apparatus

2.4.3.1 Measurement of Distance

In all calibration methods the precision of the measurement of the distance between the meter and the source is important in calculating the proper exposure rate. Errors in distance measurement are compounded by the inverse square law.

For example, from Figure 4 a $\pm$ 5 cm error in distance at 500 cm produces an error of about $\pm$ 2.0%. At 100 cm a $\pm$ 5 cm distance error results in an $\pm$ 8% uncertainty.

In Appendix B it is shown that to ensure an error of less than $\pm$ 2.0% when calibrating with a 37.0 GBq (1 Ci) source in the 10-100mGy/h (1-10R/hr) range, it is necessary to have distance measurements with a precision of at least $\pm$ 3 mm. For calibration at lower ranges, larger precision errors can be tolerated. However, to ensure reproducibility, it is recommended that a $\pm$ 3 mm precision be maintained throughout

a calibration procedure. This should be easily obtainable with good equipment.

In order to achieve the required precision it is recommended, therefore, that a fixed measuring device, meter or graduated optical bench be used. Ordinary tape measures or wooden meter sticks are generally not adequate. Ideally calibrators should have either:

(a) a moveable table with a position gauge accurate to the nearest mm or,

(b) a fixed track or optical bench with a scale fixed on the device that can be read to the nearest mm in direct line with the calibrating radiation source.

2.4.3.2 Placement of the Meter

Distance measurements should be made from the center of the source to the center of the detector unit active volume (geiger tube etc.) of the meter. If this position is not known the distance should be measured to the geometrical center of the chamber housing in the horizontal plane.

2.4.4 Effect of Radiation Attenuation and Scatter

2.4.4.1 Use of Attenuators

Field strengths in calibration rigs can be varied by using attenuators, usually constructed of a metallic material, which can absorb a certain percentage of the radiation from the calibration source.

Commercial attenuators generally have nominal attenuation coefficients associated with them for radiation of a specified type and energy. For example a set of four attenuators may have nominal values of 2, 4, 10, 100. The actual certified values may be 2.17, 4.55, 10.7 and 103.1 for a Cs-137 source. This is an 8%, 13%, 7% and 3% difference from the nominal values. If attenuators are used in a known source calibration method it is imperative that the certified values of the attenuation coefficient be used.

2.4.4.2 Effects of Scattering

In the Known Source Method the dose rate is calculated assuming a point source inverse square law holds. Source radiation scattered off nearby objects may make use of the inverse square law inappropriate. Scattered radiation can be

minimized by use of an open air beam calibrating facility that is at least 1 meter off the floor and that uses a non-metal optical bench or track system. Also the distance to any potential scattering object from the calibrating beam should be maintained at least twice the distance between the source and detector (Reference 5).

If a substitution method with a standard transfer instrument is used, scattering effects are less of a concern provided, scattering which could significantly reduce the effective energy of the calibrating field, is avoided.

2.4.5 Elimination of Other Sources of Error

2.4.5.1 Viewing and Manipulation of Instrument During Calibration

The readings obtained from the meter during calibration are usually done remotely to minimize the dose received by personnel performing the calibration. Many calibration rigs incorporate mirrors, video cameras, and/or telescopes to view the meter remotely. Also extension probes, screwdrivers, etc. are used to remotely manipulate calibration potentiometers or dials. Care must be taken in setting up devices used in remote viewing and manipulation. Error sources due to parallax, vibrations of mount, or non-reproducibility of adjustments, should be eliminated as much as possible.

2.4.5.2 Calibration Over Different Ranges

During the calibration procedure each range of a meter should be checked at a minimum of two points 25% and 75% of full scale.

Reproduciblilty can be checked by starting calibratons at the low scale and working to the high scale and then reversing the order. This would also ensure adjustments made on one scale or range does not affect the calibration of the other ranges.

2.4.5.3 Possible Environmental Effects

Meter response to environmental conditions or changes could cause additional uncertainty which may, in some cases, invalidate a calibration.

Response of meters to magnetic fields, ac/dc current, radio frequency fields, and static electricity could affect meter readings. Careful attention in placing the calibration apparatus should be given. As much as possible calibrations

should be done in an area well away from heavy electrical machinery such as motors or pumps. Electronic equipment that would generate high electromagnetic fields should be eliminated from the immediate calibration area.

If elimination of strong electromagnetic fields is not possible or if uncertainty exists on the ambient electromagnetic field levels, the meter to be calibrated could be placed in a grounded shield cage with a view port.

Meter responses to a radiation field depends to a certain extent on the ambient temperature and pressure. As much as possible a meter should be calibrated in an ambient temperature and pressure typical of the environment in which it will be used.

2.4.5.4 Electronic Response

In a calibration method the electronic response time of the detector should be taken into account. This includes allowing for the time necessary for a meter to warm up when switched on (if necessary) and time for the meter to respond to changes in strength of the radiation fields used in calibration.

2.4.5.5 Energy Response

The dose rate due to gammas measured by a survey meter depends to a certain extent on the energy of the gammas. Typical meters read within $\pm$ 25.0% of the true dose rate over the 50 KeV to 3 MeV range (Reference 6). Industrial radiography sources of Ir-192 emit gammas with energies of .316 and .468 MeV Co-60 sources emit gammas with 1.33 and 1.17 MeV energies. Most commercial survey meters have fairly flat response for gammas in the radiography source range of .3 to 1.33 MeV. However, because of the possibility of energy dependence of survey meters which could vary with manufacturer, a calibrating source should emit gammas as close as possible to the energy of gammas to be measured in the field.

From the survey of firms, most calibrators use an actual Co-60 or Ir-192 source for calibration, or else use a Cs-137 source which emits gammas or 660 MeV. The Cs-137 gamma energy (660 MeV) is approximately in the middle of the range of interest in radiography and represents an suitable calibration source.

2.4.6 Requirement for Pre-calibration Checks

Pre-calibration checks prevent attempts to calibrate an instrument which is not functioning properly. A

pre-calibration check should be performed before any calibration takes place. A precalibration check includes:

(a) inspection of the physical condition of the meter to ensure no physical damage has occurred and the instrument is not contaminated.

(b) an electronic operating check to ensure

(1) the power supply is adequate (i.e. batteries are OK)
(2) the geiger tubes or ionization chamber respond correctly. The operating point on the high voltage plateau could be checked by compiling a response versus high voltage setting curve with a check source. This verifies that the high voltage setting is correct and that the geiger tube or detector is still functioning correctly.
(3) there is no switching transients on range/scale change.
(4) the instrument is capable of achieving zero adjustment (if the dial exists).

2.4.7 Requirement for Calibration Documentation

Calibration methods must be documented. This must include;

(a) a description of the general method of calibration used

(b) the identification of the equipment used including the type of calibrator used and the strength and type of source

(c) a step-by-step written procedure.

This would allow AECB inspectors or other qualified personnel to review the methods and insure procedures and equipment are adequate.

Additionally it is mandatory that a calibration sheet with the data from the calibration be produced for each calibration.

An example of a calibration sheet is given in Figure 6.

A calibration sticker or tag should be attached to any meter that has been calibrated. The sticker should indicate:

(a) identity of the calibration company

(b) instrument number or serial number

(c) date of calibration

(d) name of the person who performed the calibration and gamma energy used

(e) due date for next calibration

(f) meter ranges calibrated

An example sticker or tag is shown in Figure 7.

2.5 QUANTITATIVE ANALYSIS OF UNCERTAINTIES IN CALIBRATION METHODS

As identified in Section 2.4 there are several sources of uncertainties which affect the absolute error in the calibration not attributable to the meter itself. The uncertainty in the meter must be taken into account as well as the uncertainty in the apparatus. The following sections examine quantitatively the inherent uncertainty associated with the three general categories of methods identified in Section 2.2.

2.5.1 Uncertainties in the Known Source Method

The typical uncertainty components of the known source method is summarized as follows;

(a) Source Strength	± 5%
(b) Uncertainty in Distance Measurement	± 2%
(c) Decay Calculation	± 1%
(d) Attenuation Coefficients	
certified values used	± .5%
nominal values used	± 7%

If the errors are treated as absolute precision errors as much as ± 15% uncertainty could exist. In practise some portion of these errors are more random in nature and should be combined in an RMS (root mean square) sense thus reducing the overall uncertainty.

Taking this into account it is estimated that the associated uncertainty with the known source method is about ± 10% to ±12% if attenuators are used with nominal values.

If attenuators are not used, or if certified values are available, the associated uncertainty would be in the range of ± 7%.

2.5.2 Uncertainties in the Substitution Method

For the substitution method, where a transfer standard meter is used to estimate the dose rate at the various calibration position, some of the uncertainties identified in the known source method do not apply. The source strength uncertainty and uncertainty from the decay calculation and attenuation coefficient do not apply. The sources of uncertainty left are;

(a) Accuracy and precision of the transfer standard meter	± 3%
(b) Uncertainty in Meter Placement	± 2%

The inherent uncertainty obtainable in the substitution method is of the order of ± 3% to ± 4%, a factor of 2 or more better than the uncertainty obtainable from the Known Source Method.

2.5.3 INHERENT UNCERTAINTY AND THE EFFECT ON CALIBRATION

As described above, there is inherent uncertainty associated with calibration methods. In order to allow for this the tolerence on acceptable readings permitted during calibration should be somewhat smaller than the overall accuracy required. It is recommended that meter calibration should be to ± 10% of the required readings which is less than the ± 20% accuracy required by current regulations (Section 3.2). Meters that cannot be calibrated to ± 10% are not acceptable for use.

3.0 CALIBRATION METHODS CURRENTLY IN USE IN INDUSTRIAL RADIOGRAPHY

3.1 SURVEY OF METHODS IN USE

As part of the study reported here, a survey of Canadian firms offering or performing calibration services was conducted. As a result of the survey, information from 11

firms was obtained. A detailed summary of information is given in Table 3.

In summary, of the 11 firms responding, 3 firms use the Substitution Method for calibration. Two of the three firms use a shielded calibration rig and the other uses a beam calibrator mounted on an optical bench. All three firms have sources with sufficient strength to perform adequate calibrations in the 1-10 R/hr range.

The other eight of the 11 firms use different variations on the Known Source Method. None of these firms however utilize a source of sufficient strength to perform calibrations in the 1-10 R/hr range.

4.0 SUMMARY OF CALIBRATION METHOD REQUIREMENTS

A summary of calibration method requirements is given below. These were derived from the considerations given in Section 2 of this report, and the current AEC requirements. They are the minimum requirement necessary to comply with the AEC regulations.

Generic Requirements

(a) The calibrating source used should be of the same type, or should have gamma decay energy close, to the gamma energy of the Camera Source used in the Industrial Radiography Process (Ir-192, Co-60).

(b) Placement of the survey meter relative to the calibrating source should be accurate enough to produce a ± 2% or less uncertainty in field strength. To achieve this accuracy the displacement technique should have reproducible accuracy of ± 3mm or less. This includes the uncertainty in the geometric center of the active volumes of the meters to be calibrated.

(c) Two points (one-third and two-thirds full scale) on each range of a meter should be calibrated within a tolerance of ± 10% of the required reading to ensure the meter meets the regulations. The ± 10% tolerance is somewhat less than the overall required accuracy of the regulations to allow for uncertainty inherent in any calibration process itself.

(d) A meter calibration should be documented as given in Section 2.4.7 and a Calibration Sticker should be placed on the meter with the information outlined in Section 2.4.7.

(e) Pre-calibration checks should be performed before any calibration takes place as described in Section 2.4.6.

(f) Environment effects such as EMF Fields which could cause additional uncertainty in, or invalidate a calibration, should be eliminated from the calibration area (Section 2.4.5.3).

(g) A Radiation Source of at least 37.0 GBq (1 Ci) or more in strength should be used to ensure adequate calibration in the 1-10 R/hr range.

Requirements for the Known Source Method.

(h) If the Known Source Method is used, precautions outlined in Section 2.4.3.2, should be undertaken to ensure any unwanted effects from scattering of source radiation are minimized.

(i) The minimum source to detector distance used in the Known Source Method should be at least seven times the largest dimension of the radiation source or detector volume of the survey meter.

(j) If a calibration procedure relies upon the Known Source Method, the calibrating source strength should be traceable to either a NBS or a NRC Primary Standard with a $\pm$ 5% or less uncertainty. Certification documents cross-referenced to the source used is required of the institution performing the calibration.

(k) If attenuators are used in the Known Source Method calibration process, the attenuation coefficients should be known accurately to $\pm$ .5%. Nominal values are not to be relied upon unless certified.

(l) Periodic checks should be made on the Known Source to ensure that source activity and fields has not changed due to physical damage of the source, source container, or source drive mechanism (see Section 2.4.1).

Requirements for the Substitution Method

(m) Effects of scattering do not affect the accuracy of the Substitution Method provided that the geometry of the scattering material close to the calibration source and beam (shielding, etc.) remain fixed during calibration and the energy of the calibrating beam is not changed significantly by the scattering process.

(n) If the Substitution Method is used in a calibration, the transfer standard instrument should have a certified accuracy of $\pm$ 5% or less, and should be recalibrated to a primary standard on a periodic basis.

(o) Uncertainty in the attenuation coefficients of attenuators used in the Substitution Method is not significant provided it is the same when measurements are made with the standard meter and the survey meter undergoing calibration.

In addition to the requirements summarized above a calibration procedure should adhere to the general guidelines outlined in Section 2 of this report.

5.0 An Optimal Method

The optimum method for calibration is the Substitution Method outlined in section 2.2.2 where calibration is performed by substitution with a transfer standard instrument accurate to ± 5%. The optimum equipment arrangement for this method would be:

(a) a shielded calibration rig described in section 2.3.2

(b) a 1 Ci Cs-137 source

(c) Calibrated attenuators which can vary the field over the 20 micro Sv/hr to 100 micro Sv/hr range but do not effect the nominal energy of the beam.

The calibration procedure should follow the guidelines set out in section 4.0 for the Substitution Method.

This method is optimal since it has a low inherent uncertainty associated with it, the equipment is precise and portable, and minimizes personnel exposure to radiation.

Although this is an optimal method, other methods could be adequate as long as the basic requirement outlined in section 4.0 are met.

6.0 SUMMARY

The calibration requirements for radiation survey meters used in Industrial Radiography have been reviewed. Information from a literature search, discussions with CSLD Inspectors and Firms performing calibration have been considered in detail.

Based on this review the requirements for adequate calibration methods have been considered in detail. Section 2 of this report describes these considerations and examines the various methods and their relative effectiveness. In particular the specific requirements to comply with current AEC regulations were derived based on the particulars of a method.

A set of minimum standards for compliance with AEC regulations were generated. These minimum standards are listed in Section 4.0 and can be used as guidelines for evaluating the adequacy of an existing or proposed calibration method.

In addition an optimal method for calibration which ensures compliance with current AEC regulations is described in

Section 5.0. However, as pointed out in Section 5.0, other methods may also be adequate as long as they meet the minimum standards listed in Section 4.0.

The main problem area encountered in the review is the calibration of detectors in the 1 to 10 R/hr dose rate range. Also as identified in discussions with Inspectors and Licensees some questions exist on the necessity for accurate calibrations in this range. It is recommended that the requirements for calibration in the 1 to 10 R/hr range be reviewed.

7.0 REFERENCES

1. Atomic Energy Control Act, Atomic Energy Control Regulations, amendment. SOR/DORS/83-459 Vol. 117, NO.1. May 20, 1983.

2. Atomic Energy Control Act, Atomic Energy Control Regulations, amendment. SOR/DORS/86-252. Vol. 120 No. 6.

3. Atomic Energy Control Board, "Regulatory Guide R-62" Atomic Energy Control Regulations: Interpretation of Revisions Relating to Industrial Radiography", September 6, 1983.

4. United States Nuclear Regulatory Commission, Rules and Regulations, Title 10 Chapters 1, Code of Federal Regulations - Energy Part 34, "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations". June 30, 1986.

5. American National Standard ANSI N323-1978, "Radiation, Protection Instrumentation Test and Calibration", September 13, 1977.

6. J.U. Burnham, "Radiation Protection Point Lepreau Generating Station" 1986.

7. Bernard Schien, Michael S Terpilak, Nuclear Lecturn Associates, "The Health Physics and Radiological Health Handbook", 1984.

8. R.W. Davis, E.R. Graves, "The Radiation Instrument Calibration Facility of the Los Alamos Scientific Laboratory, January 16, 1969.

9. International Atomic Energy Agency, "Handbook on Calibration of Radiation Protection Monitoring Instruments" Technical Report Series No. 133, 1971.

10. Atomic Energy Control Board, "Practical Reference - Radiation Standards in Canada INFO-0101, July 1983.

8.0 BIBLIOGRAPHY

Amersham, "Radioactive Calibration Sources and Standards", Amersham Canada Limited 1986.

ANS N323-1978, "Radiation Protection Instrumentation Test and Calibration. ANSI 1978.

AECB, "Quarterly Summary of Reported Incidents, July 1 - September 30, 1983" INFO-0109-3, August 28, 1984.

AECB, "Quarterly Summary of Reported Incidents October 1 - December 31, 1983", INFO-0109-4, January 1984.

Atomic Energy Control Board (AECB), "Practical Reference - Radiation Standards in Canada" AECB, INFO-0101, July 1983.

AECB, "Regulatory Guide - Atomic Energy Control Regulations: Interpretation of Revisions Relating to Industrial Radiography R-62, September 6, 1983.

AECB, "Radiation Exposures to Technologists From Nuclear Medicine Imaging Procedures" INFO-0199, May 1986.

AECB, "Notice to All Radiography Licensees, Radiography Device/Source Manufacturers and Distributers.

Atomic Energy Control Regulation, Amendments SOR/DORS/83-459 and SOR/DORS/86-252.

Bernard Shlein, Pharm. D., Terpelak, Michael S., "The Health Physics and Radiological Health Handbook," Nuclear Lecturn Associates Inc., 1984.

Black, G.S. "Point Lepreau Generating Stations Health Physics Instrument Manual 87-67820, February 1983.

Boggs, J.V., "Hazards Control Instrument Calibration Facility", California Univ., Lawrence Livermore Radiation Lab, May 6, 1971.

Burnham, J.U., "Radiation Protection Point Lepreau Generating Station," NB Power, 1986.

Canadian General Standards Board, "Manual on Industrial Radiogrpahy", 48-GP-SM August 1981.

Canadian Standards Association, CSA C22.2 No. 114-1980, "Radiation Emitting Equipment.", 1980.

Davis, RW; Graves, ER, "The Radiation Instrument Calibration Facility at the Los Almos Scientific Laboratory, Los Alamos Scientific Lab., N.Mex.) January 16, 1969.

ICRU, "Radiation Quantitre and Units", ICRU Report No. 19, October 1, 1975.

ICRU, "Specifications of High Activity Gamma-Ray Sources", ICRU Report No. 18, October 1975.

International Atomic Energy Agency, "Handbook on Calibration of Radiation Protection Monitoring Instruments", Technical Report Series No. 133, Vienna 1971.

Iles, W.J., White D.F., "Relationships between Calibration and Field Measurements with Radiation Protection Instruments." Advances in Radiation Protection Monitoring Symposium. Stockholm, IAEA-SM-229/16, June 26-30, 1978.

Isotope Products Laboratories, "Radiation Sources for Research, Industry and Environmental Applications", Products Catalog, 1986.

NCRP, "A Handbook of Radioactivity Measurements Procedures", NCRP Report No. 58, November 1, 1978.

NCRP, "Radiation Safety Training Criteria for Industrial Radiography" NCRP Report NO. 61. November 1978.

Portal G., Normalization des Methodes de Production de Rayonnements de Reference a, L'Iso et a la CCE Pour L'Etalonnage des Dosimetres et Debitmetres de Radioprotection. IAEA-SM-229/83. June 26-30, 1978.

Shepherd J.L. and Associates. "Beam Calibrations Irradiators, Single and Multiple Source, Featuring Manually or Remotely Controlled Pneumatic Operation. 1986.

U.S. Nuclear Regulatory Commission, "Guide for the Use of Sealed Sources and Devices for Performing Industrial Radiography", Washington (DC), October 1984.

U.S. Nuclear Regulatory Commissions Rules and Regulations. Title 10 Chapter 1, Code of Federal Regulations - Energy (10 CFR 34) "Licenses for Radiography and Radiations Safety Requirements for Radiographic Operations", June 30, 1986.

U.S. Nuclear Regulatory Commissions Rules and Regulations. Title 10 Chapter 1, Code of Federal Regulations - Energy (10 CFR 20), "Standards for Protection Against Radiation," June 31, 1985.

U.S. Nuclear Regulatory Commissions Rules and Regulations. Title 10 Chapter 1, Code of Federal Regulations - Energy (10 CRF 21), "Reporcing of Defects and Noncompliance" November 29, 1985.

Table 1

Decay Correction Factors for Activity and Dose Rate

Cobalt-60 Half Life 5.27 years		Cesium-137 Half Life 30.2 years	
Years after Source date	Decay Factor *	Years after Source date	Decay Factor *
0.5	0.94	1	0.98
1	0.88	2	0.96
2	0.77	3	0.93
3	0.67	4	0.91
4	0.59	5	0.89
5	0.52	6	0.87
6	0.45	7	0.85
7	0.40	8	0.83
8	0.35	9	0.81
9	0.31	19	0.79
10	0.27	15	0.71
11	0.24	20	0.63
12	0.21	25	0.56
13	0.18	30	0.50
14	0.16		
15	0.14		

* Multiplication factor to derive activity at this time interval since the source date.

Table 2

Calculated Dose Rate with Distance From

37 GBq (1 Ci) Source Activity

Source	Half Life	Photon energies MeV	Dose Rate (mGy/hour) with distance.				
			20 cm	50 cm	1 m	5 m	10 m
Cs-137	30.2 years	0.662	82	13	3	0.1	0.03
Co-60	5.27 years	1.173 1.332	350	55	14	0.6	0.1
Ir-192	73.8 days	0.316 0.468 & others	125	19	5	0.2	0.05

Data from the Radiological Health Handbook.

20 cm is, very approximately, the minimum calibration distance which should be used.

Table 3 - Summary of Calibration Techniques of Surveyed Firms.

Firm	Calibration Source		Calibration Equipment				Calibration Method		Attenuators	Precalibration Check	Documentation
	Co-60	Cs-137	Maximum Source Strength	Bench	Well	Range	Substitution	Known Source Strength			
1	-	X	9.6 TBq (260 Ci)	X	-	-	X	-	X	X	X
2	-	X	44 GBq (1.2 Ci)	-	-	X	X	-	X	?	X
3	-	X	400 MBq (10 mCi)	X	-	-	-	X	?	?	?
4	-	X	4.9 GBq (132 mCi)	X	-	-	-	X	X	?	X
5	-	X	5.6 GBq (150 mCi)	X	-	-	-	X	-	X	X
6	-	X	6.1 GBq (165 mCi)	X	-	-	-	X	?	?	?
7	-	X	?	Floor	-	-	-	X	?	?	?
8	X	-	?	?	-	-	-	X	?	?	X
9	-	X	37 GBq (1 Ci)	-	-	X	X	-	-	?	?
10	X	-	?	X	-	-	-	X	?	?	X
11	X	X	111 mBq (30 mCi)	X	-	-	-	X	-	X	?

X = In Use
? = Unknown
- = Not In Use

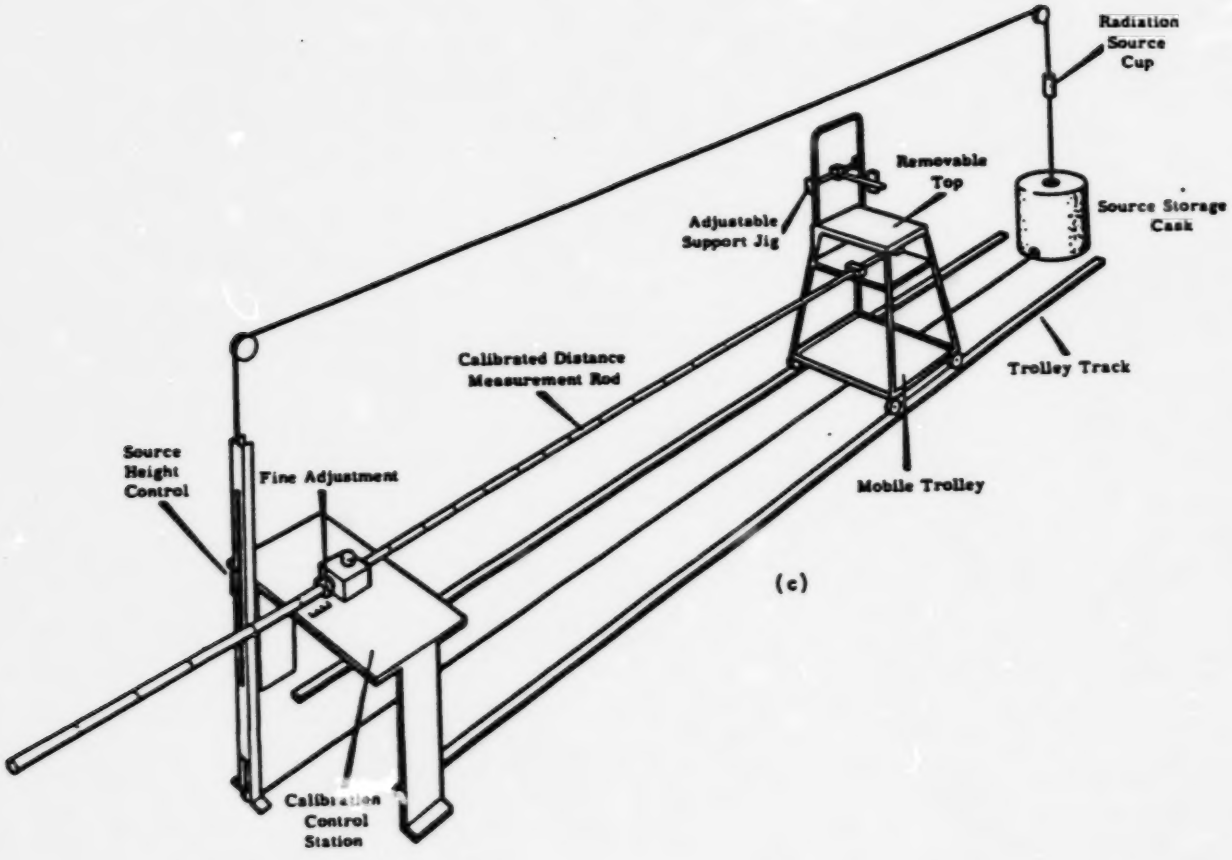

Figure 1 Example of A Beam Calibrator

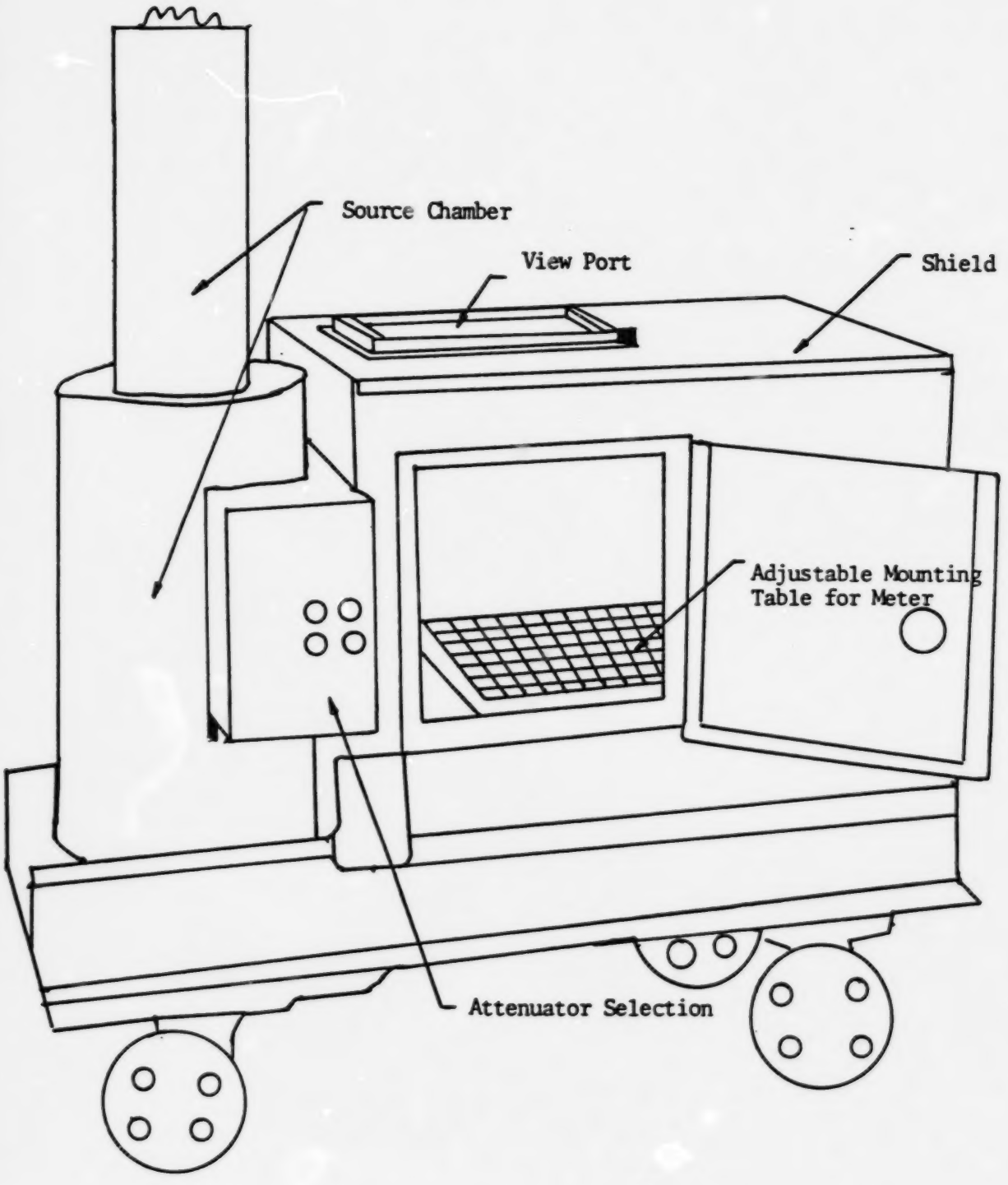

Figure 2 Example of A Shielded Calibration Rig

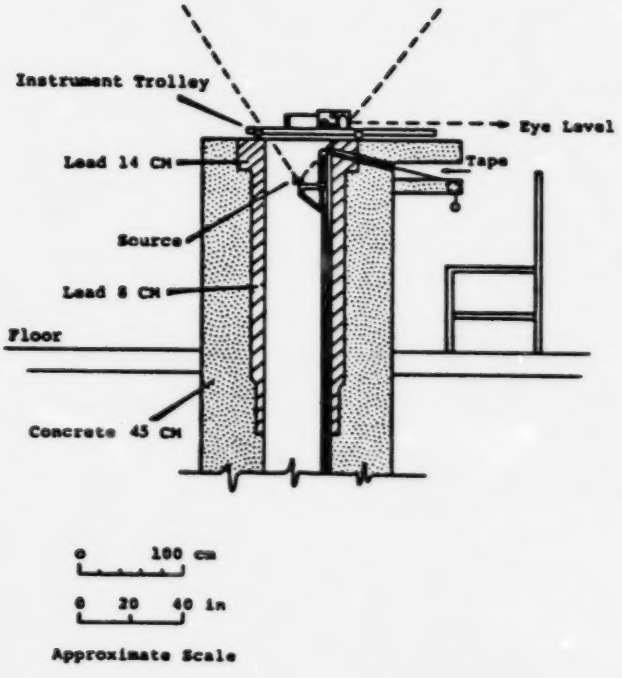

Figure 3 Example of A Calibration Well or Chimney

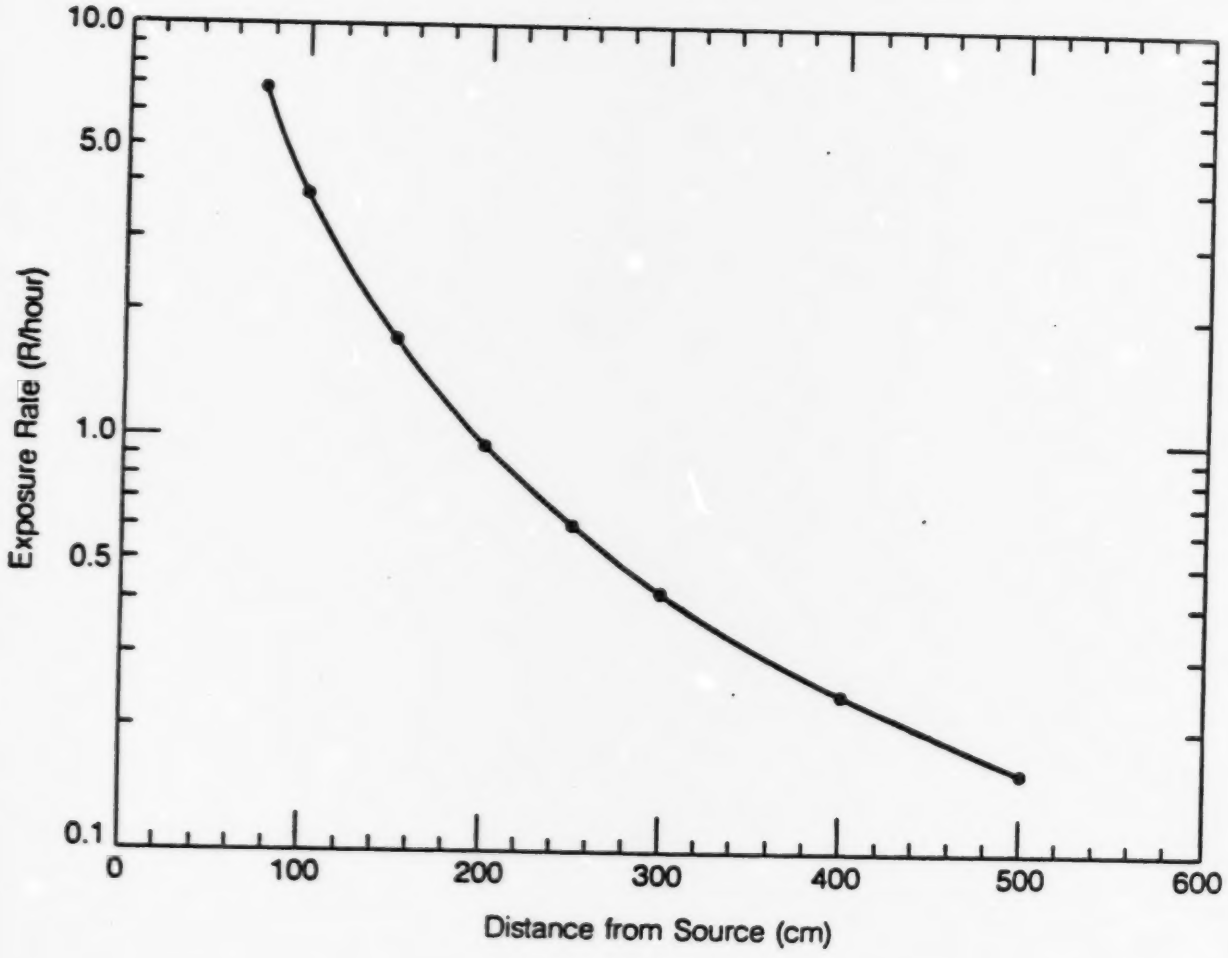

Figure 4 Typical Exposure Rate Versus Distance Curve of A 370Gbq (10 Ci) Source of Cs-137.

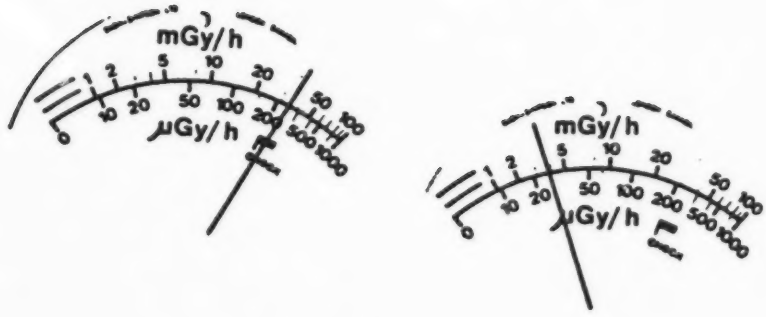

Figure 5 Example of a Meters Scale

XXX Calibrators 101 Calibrator Road
506-458-0000

Firm - XXX Radiographers
Brand: XXXX Mode: 255N Serial No. 001
Number of Ranges: 2 Range: 0-10R
Date of Last Calibration - June 16, 1986
Reason for Calibration - Due X
Equipment Repair _____
Other (Specify) _____

Calibrating Source
Make: XXX Model: 89 Source: Cs-137
Strength at date: 1 Ci

Precalibration Check
Electronic Check: OK High Voltage Setting 500
Battery Check: OK

Calibration		Values Expected	Response	Adjusted to
Range 1: 0-100 mR/hr	Check Point 1:	25 mR/hr	20 mR/hr	23 R/hr
	Check Point 2:	75 mR/hr	73 mR/hr	73 R/hr
Range 2: 0-10 R/hr	Check Point 1:	1.5 R	1.8 R/hr	1.6 R/hr
	Check Point 2:	5 R	4.8 R/hr	4.8 R/hr

Reproducibility Check Made: Yes X No _____
Remarks _____
Date Performed July 20, 1987 by: J. Smith
Calibration Tag Attached: Yes X No _____
Constancy Check Result After Calibration Check Source #111
25 mR/hr on Range 1

Figure 6 Sample Calibration Data Sheet

XXX Calibration

Inst #: 601

Date: 86-01-01

By: J. Smith

Due: 87-01-01

Uncalibrated Ranges: none

Check Source Response: Range 1 - 20 mR

Figure 7 Sample Calibration Sticker

Appendix A

Atomic Energy Control Regulation, Amendment

SOR/83-459 and SOR/86-252

Registration
SOR/83-459 20 May, 1983

ATOMIC ENERGY CONTROL ACT

Atomic Energy Control Regulations, amendment

P.C. 1983-1504 19 May, 1983

His Excellency the Governor General in Council, on the recommendation of the Minister of Energy, Mines and Resources, pursuant to section 9 of the Atomic Energy Control Act, is pleased hereby to approve the amendment made by the Atomic Energy Control Board to the Atomic Energy Control Regulations, C.R.C., c. 365, in accordance with the schedule hereto, effective August 1, 1983.

SCHEDULE

1. Section 4 of the *Atomic Energy Control Regulations* is revoked and the following substituted therefor:

"4. Subject to section 6 and subsection 18.1(5), no person shall, unless exempted in writing by the Board, use, sell or possess any device or equipment containing radioactive prescribed substances except in accordance with a licence issued pursuant to section 7."

2. Section 18 of the said Regulations is revoked and the following substituted therefor:

"18. In this section and section 18.1 to 18.23,

"approved examination" means an examination on radiation safety and industrial radiography approved by the Board; (*examen approuvé*)

"exposure device" means a device containing a prescribed substance for the purpose of carrying out radiography; (*dispositif d'exposition*)

"licensee" means a person to whom a licence is issued for the use or possession of an exposure device; (*détenteur de permis*)

"operate", in relation to an exposure device, includes locking or unlocking the exposure device, coupling a source assembly to a drive cable and moving a source capsule; (*utiliser*)

"qualified operator" means a person who has successfully completed an approved examination; (*opérateur qualifié*)

"source capsule" means any component of an exposure device that exclusively encases a prescribed substance and that is designed to prevent leakage or escape of the prescribed substance and includes the prescribed substance; (*source*)

"trainee" means a person permitted by a licensee pursuant to section 18.1 to operate an exposure device under the supervision of a trainee supervisor; (*stagiaire*)

Enregistrement
DORS/83-459 20 mai 1983

LOI SUR LE CONTRÔLE DE L'ÉNERGIE ATOMIQUE

Règlement sur le contrôle de l'énergie atomique—Modification

C.P. 1983-1504 19 mai 1983

Sur avis conforme du ministre de l'Énergie, des Mines et des Ressources et en vertu de l'article 9 de la Loi sur le contrôle de l'énergie atomique, il plaît à Son Excellence le Gouverneur général en conseil d'approuver, conformément à l'annexe ci-après et à compter du 1er août 1983, les modifications apportées par la Commission de contrôle de l'énergie atomique au Règlement sur le contrôle de l'énergie atomique, C.R.C., c. 365.

ANNEXE

1. L'article 4 du *Règlement sur le contrôle de l'énergie atomique* est abrogé et remplacé par ce qui suit:

«4. Sous réserve de l'article 6 et du paragraphe 18.1(5), il est interdit, sauf autorisation écrite de la Commission, d'utiliser, de vendre ou de posséder un dispositif ou du matériel contenant des substances prescrites radioactives, autrement qu'aux termes d'un permis délivré en vertu de l'article 7.»

2. L'article 18 dudit règlement est abrogé et remplacé par ce qui suit:

«18. Dans le présent article et les articles 18.1 à 18.23,

«détenteur de permis» désigne une personne à qui un permis a été délivré, l'autorisant à utiliser ou à posséder un dispositif d'exposition; (*licensee*)

«dispositif d'exposition» désigne un dispositif contenant une substance prescrite utilisée en radiographie; (*exposure device*)

«examen approuvé» désigne un examen en matière de radioprotection ou de radiographie industrielle approuvé par la Commission; (*approved examination*)

«opérateur qualifié» désigne une personne qui a subi avec succès un examen approuvé; (*qualified operator*)

«source» désigne tout élément d'un dispositif d'exposition qui sert exclusivement à contenir une substance prescrite de façon que celle-ci ne puisse s'échapper, et inclut la substance prescrite; (*source capsule*)

«stagiaire» désigne une personne autorisée par le détenteur de permis, aux termes de l'article 18.1 à utiliser un dispositif d'exposition sous la surveillance d'un surveillant; (*trainee*)

«surveillant d'un stagiaire» désigne un opérateur qualifié que le détenteur de permis nomme, en vertu de l'article 18.11, pour surveiller un stagiaire pendant que celui-ci utilise un dispositif d'exposition; (*trainee supervisor*)

"trainee supervisor" means a qualified operator appointed by a licensee pursuant to section 18.11 to supervise a trainee in the operation of an exposure device. (*surveillant du stagiaire*)

18.1 (1) Subject to subsections (2) to (4), no licensee shall permit any other person to use or possess an exposure device whose use or possession is the subject of his licence except as authorized under his licence.

(2) A licensee may permit a qualified operator to operate an exposure device if

(*a*) the licensee is able at all times to exercise control or supervision over the operation by the qualified operator of the exposure device; and

(*b*) the qualified operator

(i) is knowledgeable in the safe operation of the exposure device including the use of safety equipment normally associated with the exposure device, the principles of radiation protection and the procedures to be followed in the event of an accident involving the exposure device,

(ii) is familiar with these Regulations and the terms and conditions of the licensee's licence, and

(iii) is not prohibited by these Regulations from operating the exposure device.

(3) A licensee may, for the purpose of training a person to become a qualified operator, permit that person to operate an exposure device under the supervision of a trainee supervisor.

(4) A licensee may permit a person to possess an exposure device for the purpose of transporting the exposure device to any place.

(5) Any person who is permitted by a licensee pursuant to subsection (2), (3) or (4) to operate or possess an exposure device is exempt from the licensing requirements of section 4.

18.11 (1) A licensee may appoint a qualified operator to supervise a trainee in the operation of an exposure device if

(*a*) the qualified operator is, in the opinion of the licensee, qualified by reason of his knowledge, training and experience to supervise another person in the safe operation of the exposure device; and

(*b*) the licensee requests the qualified operator to supervise the trainee in the operation of the exposure device and the qualified operator gives his written consent to act accordingly.

(2) A request made by a licensee under paragraph (1)(*b*) shall be in writing and shall

(*a*) state the name of the trainee;

(*b*) state the make and model of the exposure device;

(*c*) direct the attention of the qualified operator to this section and section 18.16; and

«utiliser», dans le cas d'un dispositif d'exposition, comprend le verrouillage et le déverrouillage du dispositif d'exposition, la liaison entre la fixation d'une source et un câble de commande, et le déplacement de toute source encapsulée. (*operate*)

18.1 (1) Sous réserve des paragraphes (2) à (4), il est interdit à un détenteur de permis de permettre à une autre personne d'utiliser ou de posséder le dispositif d'exposition faisant l'objet de son permis, autrement qu'aux termes de son permis.

(2) Un détenteur de permis peut autoriser un opérateur qualifié à utiliser un dispositif d'exposition si

a) le détenteur de permis peut en tout temps contrôler ou surveiller l'utilisation que l'opérateur qualifié fait du dispositif d'exposition; et

b) l'opérateur qualifié

(i) connaît le mode d'emploi sécuritaire du dispositif d'exposition, y compris le fonctionnement du matériel de sécurité habituellement associé au dispositif d'exposition, les principes de la radioprotection et la marche à suivre en cas d'accident mettant en cause le dispositif d'exposition,

(ii) connaît bien les dispositions du présent règlement ainsi que les modalités du permis délivré au détenteur de permis, et

(iii) a le droit, aux termes du présent règlement, d'utiliser le dispositif d'exposition.

(3) Un détenteur de permis peut autoriser un stagiaire à utiliser un dispositif d'exposition sous la surveillance d'un surveillant, pour lui permettre d'acquérir la formation nécessaire pour devenir un opérateur qualifié.

(4) Un détenteur de permis peut autoriser une personne à posséder un dispositif d'exposition dans le but de le transporter à un endroit quelconque.

(5) La personne autorisée par un détenteur de permis aux termes des paragraphes (2), (3) ou (4) à utiliser ou à posséder un dispositif d'exposition est exemptée des exigences de l'article 4 relatives à l'obtention d'un permis.

18.11 (1) Un détenteur de permis peut nommer un opérateur qualifié pour surveiller un stagiaire qui utilise un dispositif d'exposition, si

a) le détenteur de permis estime que l'opérateur qualifié possède, en raison de ses connaissances, de sa formation et de son expérience, les compétences nécessaires pour surveiller une autre personne lorsqu'il s'agit d'utiliser un dispositif d'exposition sans danger; et

b) le détenteur de permis demande à l'opérateur qualifié de surveiller le stagiaire pendant que celui-ci utilise le dispositif d'exposition et l'opérateur qualifié donne son consentement par écrit.

(2) Une demande faite par le détenteur de permis en vertu de l'alinéa (1)*b*) doit être présentée par écrit et doit

a) indiquer le nom du stagiaire;

b) indiquer la marque et le modèle du dispositif d'exposition;

c) attirer l'attention de l'opérateur qualifié sur les exigences du présent article et de l'article 18.16; et

(*d*) include a copy of the licence issued in respect of the exposure device.

18.12 (1) Every licensee shall, in respect of an exposure device whose use or possession is the subject of his licence,

(*a*) keep a copy of his licence conspicuously posted at his place of business;

(*b*) keep a copy of his licence available for inspection at the premises or site at which the exposure device is present;

(*c*) attach to the exposure device a durable steel or brass tag inscribed with the name of the prescribed substance contained in the exposure device, the activity of the prescribed substance and the date of measurement of that activity;

(*d*) affix securely to the exposure device a durable and readily visible and legible sign that sets out his name, address and telephone number;

(*e*) affix securely to any container, room or enclosure in which the exposure device is stored a durable and readily visible and legible sign that sets out his name, address and telephone number and that he should be contacted in the event of any emergency involving the exposure device; and

(*f*) prepare, to the satisfaction of the Board, written instructions respecting the normal and safe operation of the exposure device and respecting the steps to be followed if

(i) an operator of the exposure device is unable, through reasonable and normal effort on his part, to cause the source capsule to return to its proper shielded position,

(ii) the source capsule is separated from the exposure device outside the normal course of operation,

(iii) the source capsule or exposure device is lost, is stolen or is damaged to an extent that could impair its normal use, or

(iv) an occurrence described in section 21 comes to the attention of an operator of the exposure device.

(2) Every licensee shall, on permitting any person to operate an exposure device whose use or possession is the subject of his license,

(*a*) provide that person with a copy of the written instructions prepared in respect of the exposure device pursuant to paragraph (1)(*f*);

(*b*) ascertain that that person is familiar with and understands the written instructions referred to in paragraph (*a*); and

(*c*) provide that person, through any arrangement that is satisfactory to that person, with

(i) all survey meters, dosimeters, tools, equipment or materials that, under these Regulations, he is required to possess before he operates the exposure device, and

(ii) a sufficient number of forms to record all information that he is required to record pursuant to paragraph 18.17(1)(*c*).

(3) Every licensee shall, in respect of an exposure device whose use or possession is the subject of his license, on receipt of a written request from the Board or a designated

d) comprendre un exemplaire du permis délivré à l'égard du dispositif d'exposition.

18.12 (1) Le détenteur de permis de dispositif d'exposition dont l'utilisation ou la possession est assujettie à son permis doit

a) afficher bien en vue un exemplaire de son permis dans son établissement;

b) conserver un exemplaire de son permis à des fins d'inspection dans chaque pièce ou endroit où se trouve le dispositif d'exposition visé par son permis;

c) fixer au dispositif d'exposition une plaque d'acier ou de laiton résistante sur laquelle figure le nom de la substance prescrite contenue dans le dispositif d'exposition, l'activité de la substance prescrite et la date du relevé de l'activité;

d) fixer solidement au dispositif d'exposition une plaque résistante, facile à voir et lisible, indiquant ses nom, adresse et numéro de téléphone;

e) fixer solidement sur tout contenant ou dans toute salle ou enceinte où le dispositif d'exposition est entreposé, une plaque résistante, facile à voir et lisible, portant ses nom, adresse et numéro de téléphone et un avis indiquant qu'il doit être averti de toute situation d'urgence mettant en cause la dispositif d'exposition;

f) établir, à la satisfaction de la Commission, des directives écrites concernant l'utilisation normale et sûre du dispositif d'exposition, ainsi que les mesures à suivre si

(i) un opérateur d'un dispositif d'exposition, malgré des efforts raisonnables normaux, est incapable de ramener la source à sa position appropriée dans le blindage,

(ii) la source se trouve séparée du dispositif d'exposition en dehors du cours normal d'utilisation,

(iii) la source ou le dispositif d'exposition est perdu, volé ou endommagé au point d'en compromettre l'utilisation normale, ou

(iv) un opérateur du dispositif d'exposition se rend compte d'un incident visé à l'article 21.

(2) Le détenteur de permis qui autorise une autre personne à utiliser le dispositif d'exposition faisant l'objet de son permis doit

a) fournir à ladite personne un exemplaire des directives écrites pour l'utilisation du dispositif d'exposition établies conformément à l'alinéa (1)*f*);

b) s'assurer que ladite personne connaît et comprend les directives écrites visées à l'alinéa *a*); et

c) fournir à ladite personne, par des dispositions qu'elle juge satisfaisantes,

(i) les détecteurs de rayonnement, les dosimètres, les outils, l'équipement ou les matériaux qu'elle est tenue d'avoir, aux termes du présent règlement, avant d'utiliser le dispositif d'exposition, et

(ii) un nombre suffisant de formules pour enregistrer les renseignements exigés à l'alinéa 18.17(1)*c*).

(3) Le détenteur de permis doit, sur réception d'une demande écrite de la Commission ou d'un fonctionnaire désigné, aviser la Commission ou le fonctionnaire désigné du

officer, notify the Board or designated officer of the time and location at which the exposure device is to be operated.

18.13 (1) Every licensee shall, in respect of an exposure device whose use or possession is the subject of his licence,

(*a*) keep the exposure device locked and securely stored when it is not in use;

(*b*) maintain the exposure device in good operating condition by regular and adequate inspection and maintenance including regular and adequate inspection and maintenance of any source assembly, source guide tube, locking mechanism, drive cable mechanism or pump that forms part of the exposure device;

(*c*) test the exposure device for leakage of the prescribed substance contained therein every six months and subsequent to any incident that may have damaged the source capsule and remove the exposure device from use if the leakage is determined to have exceeded 200 becquerels;

(*d*) measure the radiation at all parts of the surface of the exposure device following the insertion of a prescribed substance into the exposure device and remove the exposure device from use if the measurement exceeds two millisieverts per hour; and

(*e*) determine on a regular and adequate basis the radiation dosage recorded on all thermoluminescent and film dosimeters worn by persons who operate the exposure device.

(2) Every licensee shall, in respect of an exposure device whose use or possession is subject to his licence, take all necessary measures to ensure that no prescribed substance is removed from or inserted into the exposure device except by or under the continuous visual observation of a qualified operator who has experience in removing the prescribed substance from or inserting the prescribed substance into that type of exposure device.

(3) No licensee shall

(*a*) use any source capsule assembly or drive cable assembly in or with an exposure device unless it is approved by the Board and designed for that purpose; or

(*b*) modify any source capsule assembly, shielding or lock in an exposure device except as approved by the Board.

18.14 (1) Every licensee shall, in respect of an exposure device whose use or possession is the subject of his licence, limit the dose of ionizing radiation received as a result of such use or possession by any person, other than an atomic radiation worker or an employee of the licensee or of a person with whom the licensee has a contract for the services of the licensee, to 0.1 millisieverts in one week and 0.5 millisieverts in one year.

(2) The measures taken for the purpose of complying with subsection (1) shall include

(*a*) the placing of a sufficient number of signs described in subsection 22(4) at the perimeter of the area within which

moment et de l'endroit où le dispositif d'exposition en cause doit être utilisé.

18.13 (1) Le détenteur de permis du dispositif d'exposition dont l'utilisation ou la possession est assujettie à son permis doit

a) s'assurer que le dispositif d'exposition visé par son permis est gardé sous clef en un lieu sûr lorsqu'il n'est pas utilisé;

b) maintenir le dispositif d'exposition en état de fonctionnement, en soumettant à des inspections et à un entretien convenables le dispositif d'exposition, y compris la fixation de la source, le tube de guidage de la source, les dispositifs de verrouillage, les mécanismes de commande par câble et les pompes qui en font partie;

c) vérifier le dispositif d'exposition tous les six mois ou chaque fois qu'un incident pourrait avoir endommagé la source, pour détecter toute fuite de la substance prescrite qu'il contient, et mettre le dispositif d'exposition hors d'usage si la fuite est évaluée à plus de 200 becquerels;

d) mesurer l'intensité du rayonnement de toutes les parties de la surface du dispositif d'exposition, chaque fois qu'une substance prescrite est chargée dans le dispositif d'exposition, et mettre le dispositif d'exposition hors d'usage si le rayonnement dépasse deux millisieverts par heure; et

e) déterminer, à des intervalles réguliers appropriés, la dose de rayonnement absorbée par chaque dosimètre thermoluminescent ou photographique que portent les personnes qui utilisent le dispositif d'exposition.

(2) Le détenteur de permis doit prendre toutes les mesures raisonnables pour s'assurer qu'aucune substance prescrite n'est enlevée du dispositif d'exposition ni chargée à l'intérieur de celui-ci par une autre personne qu'un opérateur qualifié qui possède l'expérience nécessaire pour accomplir ces opérations, ou sous la surveillance constante de ce dernier.

(3) Il est interdit à un détenteur de permis

a) d'utiliser une fixation de la source ou un mécanisme de commande par câble dans ou avec le dispositif d'exposition, à moins que la fixation ou le mécanisme ne soit conçu à cette fin et approuvé par la Commission; ou

b) de modifier, à l'intérieur du dispositif d'exposition, une fixation, un blindage ou un mécanisme de verrouillage de la source sans l'approbation de la Commission.

18.14 (1) Le détenteur de permis doit limiter à 0,1 millisievert par semaine ou à 0,5 millisievert par année, la dose de rayonnement ionisant absorbée à la suite de l'utilisation ou de la possession du dispositif d'exposition visé par son permis, par une personne autre qu'un travailleur sous rayonnements, qu'un employé du détenteur de permis ou qu'une personne que le détenteur de permis emploie à forfait pour son propre compte.

(2) Les mesures prises pour assurer le respect du paragraphe (1) doivent comprendre:

a) l'affichage d'un nombre suffisant de panneaux avertisseurs décrits au paragraphe 22(4) autour de la zone où

(i) le dispositif d'exposition est situé, et

(i) the exposure device is located, and

(ii) the dose rate from the exposure device, as measured when the source is in the exposure position, is greater than 0.1 millisieverts per hour,

to provide adequate warning to any person who may enter the area that radiography is carried out within the area; and

(*b*) where it is not possible for a qualified operator, trainee or trainee supervisor, when operating or supervising the operation of the exposure device, to keep watch for any person who may enter the area referred to in paragraph (*a*), the erecting of a sufficient number of barricades at the perimeter of the area or the posting of a sufficient number of security personnel near the perimeter of the area to prevent any person who is not an atomic radiation worker from entering the area.

(3) Where an exposure device is operated by a qualified operator or trainee on the premises of the licensee or of a person with whom the licensee has a contract for the services of the licensee and the licensee is unable to demonstrate to the satisfaction of the Board that the measures taken pursuant to subsection (2) are sufficient to limit the dose of ionizing radiation in accordance with subsection (1), the dose rate from the exposure device shall not exceed 2.5 microsieverts per hour measured at the perimeter of the area within which the movement of persons can be controlled by the qualified operator or by the trainee and the trainee supervisor who is supervising the trainee in the operation of the exposure device.

18.15 (1) No person shall operate an exposure device unless

(*a*) he is a qualified operator or is, while operating the exposure device, under the continuous visual observation and supervision of a trainee supervisor;

(*b*) he has in his possession or readily available to him the following:

(i) a copy of the written instructions prepared in respect of the exposure device pursuant to paragraph 18.12(1)(*f*), and

(ii) a properly functioning gamma radiation survey meter that

(A) is suitable for measuring gamma radiation emitted by the source capsule in the range from 20 microsieverts to 100 millisieverts per hour with an accuracy of 20 per cent of the true dose rate,

(B) incorporates facilities for testing the batteries that provide its power, and

(C) has been adequately calibrated within the 12 month period preceding the operation of the exposure device;

(*c*) where the exposure device is operated with a source guide tube, he has in his possession or readily available to him the following:

(i) material of a composition and construction sufficient to attenuate by a factor of at least 100 all gamma radiation emitted by the source capsule when the material is directly positioned over the exposed source capsule,

(ii) le taux de dose provenant du dispositif d'exposition et relevé lorsque la source émet un rayonnement, dépasse 0,1 millisievert par heure,

pour signaler de façon appropriée à toute personne qui pourrait pénétrer dans la zone que des travaux de radiographie sont en cours; et

b) si un opérateur qualifié, un stagiaire ou un surveillant n'est pas en mesure d'interdire les entrées dans la zone visée à l'alinéa *a*), lorsqu'il utilise ou qu'il surveille l'utilisation du dispositif d'exposition, la mise en place d'un nombre suffisant de barrières autour de la zone ou l'affectation d'un nombre suffisant d'agents de sécurité près de l'enceinte de la zone, afin d'empêcher toute personne au niveau prévu au paragraphe (1), autre qu'un travailleur sous rayonnements de pénétrer dans la zone.

(3) Lorsqu'un opérateur qualifié ou un stagiaire utilise un dispositif dans les locaux du détenteur de permis ou d'une personne que le détenteur emploie à forfait pour son propre compte, et que le détenteur de permis ne peut pas prouver à la satisfaction de la Commission que les mesures prises conformément au paragraphe (2) sont suffisantes pour limiter la dose de rayonnement ionisant au niveau prévu au paragraphe (1), le taux de dose provenant du dispositif d'exposition ne doit pas dépasser 2,5 microsieverts par heure autour de la zone où les mouvements des personnes peuvent être contrôlés par l'opérateur qualifié ou le surveillant qui surveille le stagiaire dans l'utilisation du dispositif d'exposition.

18.15 (1) Il est interdit d'utiliser un dispositif d'exposition, à moins

a) d'être un opérateur qualifié ou de se trouver sous l'observation visuelle et la surveillance constantes d'un surveillant pendant l'utilisation du dispositif d'exposition;

b) de posséder ou de pouvoir se procurer facilement

(i) un exemplaire des directives écrites établies à l'égard du dispositif d'exposition conformément à l'alinéa 18.12(1)(*f*), et

(ii) un détecteur de rayons gamma en bon état qui

(A) peut mesurer le rayonnement gamma émis par la source entre 20 microsieverts et 100 millisieverts par heure, compte tenu d'une marge d'erreur de 20 pour cent du taux véritable de la dose absorbée,

(B) comprend les dispositifs nécessaires pour vérifier les piles qui alimentent le détecteur en énergie, et

(C) a été calibré de façon adéquate dans les 12 mois précédant l'utilisation du dispositif d'exposition;

c) de posséder ou de pouvoir se procurer facilement, lorsque le dispositif d'exposition est utilisé avec un tube de guidage de la source:

(i) du matériel dont la composition et la fabrication permettent d'atténuer d'au moins 100 fois l'intensité de tout rayonnement gamma libéré par la source lorsque le matériel se trouve directement au-dessus de la source exposée,

(ii) des outils permettant de séparer le tube de guidage de la source et le câble de commande du reste du dispositif d'exposition, et

(ii) tools suitable for severing the source guide tube and drive cable from the remainder of the exposure device, and

(iii) tongs with a handle at least 1.5 m long suitable for safely handling the source capsule if it is separated from the exposure device outside the normal course of operation;

(*d*) he carries or wears a thermoluminescent or film dosimeter

(i) of a type and at a location suitable for recording any radiation dosage to his body, and

(ii) supplied by a dosimetry service approved by the Board;

(*e*) he wears a direct reading dosimeter of a type and worn in a manner suitable for indicating a radiation dosage to his body up to two millisieverts;

(*f*) he wears, if he is a trainee, an alarming dosimeter

(i) of a type and worn in a manner suitable for indicating a radiation dosage to his body up to two millisieverts, and

(ii) that emits an audible warning signal at a pre-set integrated dose less than two millisieverts or emits an audible warning signal whose frequency or intensity increases in proportion to an increase in the dose rate;

(*g*) he examines, immediately prior to operating the exposure device, the locking mechanism of the exposure device and, if present as a component part of the exposure device, the cranking device, drive cable, pneumatic pump, shutter mechanism, source coupling and source guide tube and determines that they each function properly; and

(*h*) he determines, immediately prior to operating the exposure device, that there is a sufficient number of suitably marked signs or barricades placed in the area where the exposure device is located or a sufficient number of security personnel posted in that area to prevent the inadvertent entry of any person who is not an atomic radiation worker into an area in which the radiation exposure dosages may exceed the dosages referred to in subsections 18.14(1) to (3).

(2) No person shall operate an exposure device if his capacity to operate the exposure device is impaired by drug or alcohol.

18.16 (1) No trainee supervisor shall permit a trainee to operate an exposure device unless he is satisfied that

(*a*) the trainee is knowledgeable in the operation of the exposure device to an extent that he is able to safely operate the exposure device;

(*b*) the trainee is not prohibited by section 18.15 from operating the exposure device; and

(*c*) no danger to the health or safety of any person will result from the operation by the trainee of the exposure device.

(2) Where a trainee supervisor permits a trainee to operate an exposure device, the trainee supervisor shall maintain

(iii) des bras munis d'une poignée d'au moins 1,5 m de longueur permettant de manipuler la source sans danger, si la source se trouve séparée du dispositif d'exposition en dehors du cours normal d'utilisation;

d) de transporter ou de porter sur soi un dosimètre thermoluminescent ou photographique

(i) d'un modèle approprié et en un endroit où le dosimètre peut enregistrer la dose de rayonnement absorbée par le corps entier, et

(ii) fourni par un service de dosimétrie approuvé par la Commission;

e) de porter sur soi de façon appropriée un dosimètre à lecture directe qui indique la dose de rayonnement absorbée par le corps entier jusqu'à concurrence de deux millisieverts;

f) de porter sur soi, s'il s'agit d'un stagiaire, un dosimètre sonore

(i) d'un modèle approprié et de manière à indiquer la dose de rayonnement absorbée par le corps entier jusqu'à concurrence de deux millisieverts, et

(ii) qui fait entendre un avertissement sonore lorsque la dose absorbée atteint un niveau prédéterminé inférieur à deux millisieverts, ou un avertissement sonore dont la fréquence ou l'intensité est proportionnelle au taux de la dose;

g) d'examiner, immédiatement avant d'utiliser le dispositif d'exposition, le mécanisme de verrouillage du dispositif d'exposition, ainsi que le mécanisme à manivelle, le câble de commande, la pompe pneumatique, le mécanisme d'obturation, la fixation de la capsule et le tube de guidage de la source, s'ils font partie intégrante du dispositif d'exposition, et de déterminer que chacun est en état de fonctionnement; et

h) de déterminer, immédiatement avant d'utiliser le dispositif d'exposition, s'il existe suffisamment de panneaux avertisseurs ou de barrières portant les signaux appropriés dans la zone où le dispositif d'exposition est situé, ou s'il y a suffisamment d'agents de sécurité dans cette zone, pour empêcher toute personne qui n'est pas un travailleur sous rayonnements de pénétrer sans raison dans une zone où la dose d'exposition aux rayonnements peut dépasser les doses mentionnées aux paragraphes 18.14(1) à (3).

(2) Il est interdit à quiconque d'utiliser un dispositif d'exposition si son habileté à utiliser le dispositif d'exposition est affaiblie par la drogue ou l'alcool.

18.16 (1) Un surveillant d'un stagiaire ne peut autoriser un stagiaire à utiliser un dispositif d'exposition que s'il est convaincu

a) que le stagiaire connaît le mode d'emploi du dispositif d'exposition au point de pouvoir utiliser le dispositif d'exposition sans danger;

b) que les dispositions de l'article 18.15 n'interdisent pas au stagiaire d'utiliser le dispositif d'exposition; et

c) que l'utilisation du dispositif d'exposition par le stagiaire ne mettra pas en danger la santé ou la sécurité d'autres personnes.

(2) Le surveillant d'un stagiaire qui autorise un stagiaire à utiliser un dispositif d'exposition doit assurer une observa-

a continuous visual observation and supervision of the trainee during the operation of the exposure device and if, during that operation, the trainee breaches any provision of these Regulations, the trainee supervisor shall immediately remove the exposure device from the possession of the trainee or shall prevent the trainee from further operating the exposure device.

(3) A trainee supervisor shall report forthwith to the licensee

(*a*) any occurrence described in paragraph 18.12(1)(*f*), subsection 18.18(1) or section 18.19 that involves a trainee under his supervision; and

(*b*) any breach of these Regulations by a trainee under his supervision.

(4) No person other than a trainee supervisor shall supervise a trainee in the operation of an exposure device.

18.17 (1) Every person who operates an exposure device shall

(*a*) determine, by using a survey meter, that the source capsule has returned to the proper shielded position in the exposure device after each operation of the exposure device;

(*b*) take every reasonable precaution to ensure that the dose of ionizing radiation received as a result of such operation by any person, other than an atomic radiation worker or an employee of the licensee or of a person with whom the licensee has a contract for the service of the licensee, is limited to 0.1 millisieverts in one week and 0.5 millisieverts in one year;

(*c*) after each operation of the exposure device or at the end of each day of operation, record the maximum reading of radiation dosage indicated on the direct reading dosimeter worn by him during the operation of the exposure device or on the day of operation; and

(*d*) lock and securely store the exposure device immediately after he has finished operating the exposure device.

(2) Every person who is permitted by a licensee to possess an exposure device for the purpose of transporting it to any place shall keep it securely stored during its transportation to that place.

18.18 (1) Any person who, in the course of operating an exposure device, observes on a direct reading dosimeter a radiation dosage measurement greater than two millisieverts shall immediately cease operating the exposure device and shall not operate any other exposure device until it has been ascertained that he has not received any dose of ionizing radiation in excess of any dose rate specified in respect of him in Schedule II.

(2) No person shall operate an exposure device whose operation was ceased pursuant to subsection (1) unless it has been ascertained that the radiation dosage measured to be greater than two millisieverts was not caused by a defect or malfunction of the exposure device or, if the dosage was caused by a defect or malfunction of the exposure device, the defect or malfunction has been corrected.

tion visuelle et une surveillance constantes du stagiaire pendant l'utilisation du dispositif d'exposition; si le stagiaire enfreint une disposition du présent règlement pendant cette utilisation, le surveillant doit immédiatement lui enlever le dispositif d'exposition ou l'empêcher de continuer à l'utiliser.

(3) Le surveillant d'un stagiaire doit signaler sur-le-champ au détenteur de permis

a) tout incident visé à l'alinéa 18.12(1)*f*), au paragraphe 18.18(1) ou à l'article 18.19 qui met en cause un stagiaire qu'il surveille; et

b) toute infraction au présent règlement commise par un stagiaire qu'il surveille.

(4) Seul un surveillant d'un stagiaire peut surveiller un stagiaire qui utilise un dispositif d'exposition.

18.17 (1) Quiconque utilise un dispositif d'exposition doit

a) vérifier, à l'aide d'un détecteur de rayonnements, que la source a réintégré sa position blindée appropriée dans le dispositif d'exposition après chaque utilisation du dispositif d'exposition;

b) prendre toutes les précautions raisonnables pour s'assurer que la dose de rayonnement ionisant absorbée à la suite d'une telle utilisation par une personne autre qu'un travailleur sous rayonnements, qu'un employé du détenteur de permis ou qu'une personne que le détenteur de permis emploie à forfait pour son propre compte, se limite à 0,1 millisievert par semaine à 0,5 millisievert par année;

c) après chaque utilisation du dispositif d'exposition ou à la fin de chaque journée d'utilisation, enregistrer le relevé maximal de la dose de rayonnement au dosimètre à lecture directe qu'il porte pendant l'utilisation du dispositif d'exposition ou la journée de l'utilisation; et

d) verrouiller le dispositif d'exposition et l'entreposer dans un endroit sûr immédiatement après l'utilisation.

(2) Toute personne autorisée par un détenteur de permis à posséder un dispositif d'exposition dans le but de le transporter à un endroit quelconque doit placer ce dispositif dans un lieu sûr pendant le transport.

18.18 (1) Toute personne qui, en utilisant un dispositif d'exposition, constate une mesure de dose de rayonnement supérieure à deux millisieverts sur un dosimètre à lecture directe, doit immédiatement cesser d'utiliser le dispositif d'exposition et n'utiliser aucun autre dispositif d'exposition avant qu'on ait vérifié que ladite personne n'a pas reçu une dose de rayonnement ionisant supérieure à la dose applicable visée à l'annexe II.

(2) Il est interdit d'utiliser un dispositif d'exposition dont l'utilisation a été interrompue conformément au paragraphe (1), à moins qu'on ne puisse établir que la dose de rayonnement dépassant deux millisieverts n'a pas été provoquée par une défectuosité ou une défaillance du dispositif d'exposition ou, dans le cas où la dose de rayonnement excessive a été provoquée par une défectuosité ou une défaillance du dispositif d'exposition, que cette défectuosité ou cette défaillance a été corrigée.

18.19 No person shall operate an exposure device that does not function in an ordinary manner or whose radiation dose rate at any part of its surface is determined to exceed two millisieverts per hour.

18.20 (1) No person who is permitted by a licensee pursuant to section 18.1 to operate or possess an exposure device shall remove any prescribed substance from or insert any prescribed substance into the exposure device unless he

(*a*) is requested in writing by the licensee to do so and gives his written consent; and

(*b*) is a qualified operator or is under the continuous visual observation of a qualified operator who has experience in removing the prescribed substance from or inserting the prescribed substance into that type of exposure device.

(2) Every person who removes any prescribed substance from or inserts any prescribed substance into an exposure device shall measure the radiation levels and radiation exposure dosages during the course of and forthwith after the completion of the removal or insertion.

18.21 No person who is permitted by a licensee pursuant to section 18.1 to operate or possess an exposure device shall modify the source capsule assembly, shielding or lock in the exposure device.

18.22 (1) Every person who is permitted by a licensee pursuant to section 18.1 to operate or possess an exposure device shall

(*a*) submit to the licensee at the end of each semi-monthly period all thermoluminescent and film dosimeters worn by him during the period;

(*b*) submit to the licensee at the end of each semi-monthly period all records made by him pursuant to paragraph 18.17(1)(*c*) during the period; and

(*c*) report forthwith to the licensee any occurrence described in paragraph 18.12(1)(*f*), subsection 18.18(1) or section 18.19 involving his operation or possession of the exposure device.

(2) In addition to the reporting requirements set out in sections 20 and 21, every licensee shall, in respect of an exposure device whose use or possession is the subject of his licence, report forthwith to an inspector

(*a*) any malfunctioning of the exposure device that could result in an increase in the level of radiation measurable at any part of the surface of the exposure device;

(*b*) any occurrence described in paragraph 18.12(1)(*f*) involving the exposure device; and

(*c*) any removal from use of the exposure device pursuant to paragraph 18.13(1)(*c*) or (*d*).

18.23 (1) Every licensee shall, in respect of an exposure device whose use or possession is the subject of his licence, keep the following records:

(*a*) a record of the name of the manufacturer, the model number, the serial number, the activity of the prescribed substance, the dates and places of use and the date of

18.19 Il est interdit d'utiliser un dispositif d'exposition qui ne fonctionne pas normalement ou dont le débit de dose de rayonnement sur n'importe quelle partie de sa surface dépasse deux millisieverts par heure.

18.20 (1) Il est interdit à toute personne autorisée par un détenteur de permis aux termes de l'article 18.1 à utiliser ou à posséder un dispositif d'exposition, d'enlever une substance prescrite du dispositif d'exposition ou d'y insérer une telle substance, à moins

a) que le détenteur de permis ne le lui demande par écrit et que ladite personne n'y consente par écrit; et

b) que ladite personne ne soit un opérateur qualifié ou qu'elle ne se trouve sous l'observation visuelle constante d'un opérateur qualifié qui connaît bien le mode de retrait ou d'insertion de la substance prescrite par rapport au modèle particulier du dispositif d'exposition.

(2) Quiconque enlève une substance prescrite d'un dispositif d'exposition ou y insère une substance prescrite doit mesurer les niveaux de rayonnement et les doses d'exposition aux rayonnements pendant et immédiatement après la fin du retrait ou l'insertion.

18.21 Il est interdit à toute personne autorisée par un détenteur de permis aux termes de l'article 18.1 à utiliser ou a posséder un dispositif d'exposition, de modifier la fixation de la source, le blindage ou le mécanisme de verrouillage à l'intérieur du dispositif d'exposition.

18.22 (1) Toute personne autorisée par un détenteur de permis aux termes de l'article 18.1 à utiliser ou à posséder un dispositif d'exposition doit

a) soumettre au détenteur de permis, à la fin de chaque quinzaine, les dosimètres thermoluminescents ou photographiques qu'elle a portés au cours de la période;

b) soumettre au détenteur de permis, à la fin de chaque quinzaine, les relevés qu'elle a enregistrés au cours de la période conformément à l'alinéa 18.17(1)*c*); et

c) faire rapport sur-le-champ au détenteur de permis de tout incident visé à l'alinéa 18.12(1)*f*), au paragraphe 18.18(1) ou à l'article 18.19, qui met en cause le dispositif d'exposition.

(2) Outre les rapports exigés aux articles 20 et 21, le détenteur de permis doit immédiatement faire un rapport à un inspecteur au sujet

a) d'une défaillance du dispositif d'exposition qui pourrait entraîner une augmentation du niveau de rayonnement mesurable sur n'importe quelle surface du dispositif d'exposition;

b) d'un incident visé à l'alinéa 18.12(1)*f*) qui met en cause le dispositif d'exposition; et

c) de la mise hors d'usage du dispositif d'exposition conformément à l'alinéa 18.13(1)*c*) ou *d*).

18.23 (1) Le détenteur de permis de dispositif d'exposition dont l'utilisation ou la possession est assujettie à son permis doit tenir les registres suivants:

a) un registre indiquant le nom du fabricant, le numéro de modèle, le numéro de série, l'activité de la substance prescrite, les dates et les endroits d'utilisation, ainsi que

procurement and disposal of the exposure device and each source capsule;

(*b*) a record of the names of all persons whom he has permitted to operate or possess the exposure device and the dates of such operation or possession;

(*c*) a record of all requests made by him pursuant to subsection 18.11(1) and 18.20(1) and all written consents thereto;

(*d*) a record of every test, measurement, inspection, maintenance or calibration taken or carried out in respect of the exposure device pursuant to these Regulations;

(*e*) a record for each operator of the exposure device of any measurements submitted to him by the operator pursuant to these Regulations;

(*f*) a record for each operator of the exposure device of the radiation dosages received by the operator and determined from thermoluminescent or film dosimeters and from direct reading dosimeters required to be carried or worn by the operator pursuant to these Regulations.

(2) Every licensee required by subsection (1) to keep records shall

(*a*) retain those records until the expiration of three years from the end of the calendar year in which they are made; and

(*b*) provide a copy of those records to the Board upon its written request.

(3) Where a licensee intends to dispose of any records referred to in subsection (1) after the expiration of the period in respect of which those records are required to be kept, the licensee shall

(*a*) give the Board reasonable notice of his intention to dispose of those records; and

(*b*) deposit those records or a copy thereof with the Board upon its written request."

EXPLANATORY NOTE

(This note is not part of the Regulation, but is intended only for information purposes.)

These amendments revise the requirements respecting the use and possession of exposure devices for the purposes of industrial radiography.

les dates d'acquisition et d'élimination du dispositif d'exposition et de chaque source;

b) un registre indiquant le nom des personnes autorisées par le détenteur de permis à utiliser ou à posséder le dispositif d'exposition, ainsi que les dates d'utilisation ou de possession;

c) un registre des demandes faites par le détenteur de permis conformément aux paragraphes 18.11(1) et 18.20(1) et des consentements écrits afférents;

d) un registre des essais, des mesures, des inspections des travaux d'entretien et de calibration que ladite personne a effectués sur le dispositif d'exposition, conformément au présent règlement;

e) un registre, pour chaque opérateur du dispositif d'exposition, des relevés que celui-ci lui a soumis conformément au présent règlement;

f) un registre, pour chaque opérateur, des relevés de toutes les doses de rayonnement reçues par l'opérateur et déterminées par le dosimètre thermoluminescent ou photographique et le dosimètre à lecture directe que l'opérateur doit transporter ou porter sur lui, conformément au présent règlement.

(2) Le détenteur de permis doit

a) conserver les dossiers visés au paragraphe (1) pendant une période de trois ans à compter de la fin de l'année civile où ils ont été établis; et

b) déposer un exemplaire de ces dossiers auprès de la Commission si elle lui en fait la demande par écrit.

(3) Lorsque le détenteur de permis a l'intention de se défaire des dossiers visés au paragraphe (1) après l'expiration de la période prévue pour leur conservation, il doit,

a) donner à la Commission un préavis raisonnable de son intention de se défaire de ces dossiers; et

b) déposer lesdits dossiers ou un exemplaire de ceux-ci auprès de la Commission, si elle lui en fait la demande par écrit.»

NOTE EXPLICATIVE

(La présente note ne fait pas partie du règlement et n'est publiée qu'à titre d'information.)

Ces modifications révisent les exigences concernant l'utilisation et la possession des dispositifs d'exposition à des fins de radiographie industrielle.

QUEEN'S PRINTER FOR CANADA, OTTAWA, 1983 IMPRIMEUR DE LA REINE POUR LE CANADA, OTTAWA, 1983

Registration
SOR/86-252 27 February, 1986

ATOMIC ENERGY CONTROL ACT

Atomic Energy Control Regulations, amendment

P.C. 1986-460 27 February, 1986

Her Excellency the Governor General in Council, on the recommendation of the Minister of Energy, Mines and Resources, pursuant to section 9 of the Atomic Energy Control Act, is pleased hereby to approve the amendments made by the Atomic Energy Control Board to the Atomic Energy Control Regulations, C.R.C., c. 365, in accordance with the schedule hereto.

SCHEDULE

1. Subparagraph 6(2)(*g*)(ii) of the *Atomic Energy Control Regulations* is revoked and the following substituted therefor:

"(ii) the design of the device and the method of incorporating the radioactive isotopes are approved by the Board or a designated officer; and"

2. (1) All that portion of subsection 7(2) of the said Regulations preceding paragraph (*a*) thereof is revoked and the following substituted therefor:

"(2) An application for a licence for any purpose referred to in section 3 or in respect of any device or equipment referred to in section 4 shall set out such of the following information as the Board or a designated officer may require:"

(2) All that portion of subsection 7(3) of the said Regulations preceding paragraph (*a*) thereof is revoked and the following substituted therefor:

"(3) A licence issued by the Board or a designated officer pursuant to subsection (1) may contain such conditions as the Board or the designated officer deems necessary in the interests of health, safety and security and, without limiting the generality of the foregoing, may include conditions respecting"

3. Paragraph 11(1)(*e*) of the said Regulations is revoked and the following substituted therefor:

"(*e*) keep such other records as the Board or a designated officer may require in the interests of health, safety and security."

4. Paragraph 17(3)(*b*) of the said Regulations is revoked and the following substituted therefor:

"(*b*) if requested by the Board or a designated officer, submit a copy of the list referred to in paragraph (*a*) and all amendments thereto to the Board and the radiation safety adviser appointed under section 16 in respect of the place where such workers are employed."

Enregistrement
DORS/86-252 27 février 1986

LOI SUR LE CONTRÔLE DE L'ÉNERGIE ATOMIQUE

Règlement sur le contrôle de l'énergie atomique—Modification

C.P. 1986-460 27 février 1986

Sur avis conforme du ministre de l'Énergie, des Mines et des Ressources et en vertu de l'article 9 de la Loi sur le contrôle de l'énergie atomique, il plaît à Son Excellence le Gouverneur général en conseil d'approuver, conformément à l'annexe ci-après, les modifications apportées par la Commission de contrôle de l'énergie atomique au Règlement sur le contrôle de l'énergie atomique, C.R.C., ch. 365.

ANNEXE

1. L'alinéa 6(2)*g*)(ii) du *Règlement sur le contrôle de l'énergie atomique* est abrogé et remplacé par ce qui suit:

«(ii) la conception du dispositif et la méthode d'incorporation des isotopes sont approuvés par la Commission ou un fonctionnaire désigné; et»

2. (1) Le passage du paragraphe 7(2) du même règlement qui précède l'alinéa *a*) est abrogé et remplacé par ce qui suit:

«(2) Une demande de permis pour toute fin mentionnée à l'article 3 ou pour un dispositif ou du matériel mentionné à l'article 4 doit donner les renseignements que la Commission ou un fonctionnaire désigné peut exiger parmi les suivants:»

(2) Le passage du paragraphe 7(3) du même règlement qui précède l'alinéa *a*) est abrogé et remplacé par ce qui suit:

«(3) Un permis délivré par la Commission ou un fonctionnaire désigné en vertu du paragraphe (1) peut stipuler toutes les conditions que la Commission ou le fonctionnaire désigné estime nécessaires dans l'intérêt de l'hygiène, de la sûreté et de la sécurité et, entre autres, sans restreindre la portée générale de ce qui précède,»

3. L'alinéa 11(1)*e*) du même règlement est abrogé et remplacé par ce qui suit:

«*e*) tenir tous les dossiers que la Commission ou un fonctionnaire désigné peut exiger dans l'intérêt de l'hygiène, de la sûreté et de la sécurité.»

4. L'alinéa 17(3)*b*) du même règlement est abrogé et remplacé par ce qui suit:

«*b*) sur demande de la Commission ou d'un fonctionnaire désigné, présenter une copie de la liste mentionnée à l'alinéa *a*), y compris ses modifications, à la Commission et au conseiller en radioprotection nommé en vertu de l'article 16 pour le lieu où lesdites personnes sont employées.»

5. (1) The definitions "approved examination"[1], "operate"[1] and "trainee supervisor"[1] in section 18 of the said Regulations are revoked and the following substituted therefor in alphabetical order within the section:

" "approved examination" means an examination on radiation safety in industrial radiography approved by the Board or a designated officer; (*examen approuvé*)

"operate", in respect of an exposure device, includes locking or unlocking the exposure device, coupling a source assembly to a drive cable, moving a source capsule and removing from and inserting into the exposure device any prescribed substance; (*utiliser*)

"trainee supervisor" means a qualified operator appointed by a licensee pursuant to section 18.11 to supervise a trainee in the operation of an exposure device. (*surveillant*)"

(2) The definition "surveillant d'un stagiaire" in section 18 of the French version of the said Regulations is revoked.

(3) Section 18[1] of the French version of the said Regulations is further amended by adding thereto, in alphabetical order within the section, the following definition:

" «surveillant» désigne un opérateur qualifié que le détenteur de permis nomme, en vertu de l'article 18.11, pour surveiller un stagiaire pendant que celui-ci utilise un dispositif d'exposition; (*trainee supervisor*)"

6. Subsection 18.1(3)[1] of the French version of the said Regulations is revoked and the following substituted therefor:

"(3) Un détenteur de permis peut autoriser un stagiaire à utiliser un dispositif d'exposition sous la surveillance d'un surveillant, pour permettre au stagiaire d'acquérir la formation nécessaire pour devenir un opérateur qualifié."

7. (1) Paragraph 18.12(1)(*c*)[1] of the said Regulations is revoked and the following substituted therefor:

"(*c*) attach securely to the exposure device by means of metal fasteners a durable steel or brass tag inscribed with the name of the prescribed substance contained in the exposure device, the activity of the prescribed substance and the date of measurement of that activity;"

(2) Paragraph 18.12(1)(*e*)[1] of the said Regulations is revoked and the following substituted therefor:

"(*e*) affix securely to any room, enclosure or vehicle in which the exposure device is stored a durable, readily visible and legible sign that sets out his name, address and telephone number and that he should be contacted in the event of any emergency involving the exposure device; and"

(3) All that portion of paragraph 18.12(1)(*f*)[1] preceding subparagraph (i) thereof is revoked and the following substituted therefor:

"(*f*) prepare, to the satisfaction of the Board or a designated officer, written instructions respecting the normal and safe

[1] SOR/83-459, 1983 *Canada Gazette* Part II, p. 2313

5. (1) Les définitions de «examen approuvé»[1] et «utiliser»[1], à l'article 18 du même règlement sont abrogées et respectivement remplacées par ce qui suit:

« «examen approuvé» désigne un examen de radioprotection en radiographie industrielle approuvé par la Commission ou un fonctionnaire désigné; (*approved examination*)

«utiliser», dans le cas d'un dispositif d'exposition, comprend le verrouillage ou le déverrouillage du dispositif d'exposition, la liaison entre la fixation d'une source et un câble de commande, le déplacement d'une source, ainsi que l'insertion d'une substance prescrite dans le dispositif d'exposition ou son enlèvement d'un tel dispositif. (*operate*)»

(2) La définition de «surveillant d'un stagiaire», à l'article 18 de la version française du même règlement, est abrogée.

(3) L'article 18[1] de la version française du même règlement est modifié par insertion, suivant l'ordre alphabétique, de ce qui suit:

« «surveillant» désigne un opérateur qualifié que le détenteur de permis nomme, en vertu de l'article 18.11, pour surveiller un stagiaire pendant que celui-ci utilise un dispositif d'exposition; (*trainee supervisor*)»

6. Le paragraphe 18.1(3)[1] de la version française du même règlement est abrogé et remplacé par ce qui suit:

«(3) Un détenteur de permis peut autoriser un stagiaire à utiliser un dispositif d'exposition sous la surveillance d'un surveillant, pour permettre au stagiaire d'acquérir la formation nécessaire pour devenir un opérateur qualifié.»

7. (1) L'alinéa 18.12(1)*c*)[1] du même règlement est abrogé et remplacé par ce qui suit:

«*c*) fixer solidement au dispositif d'exposition, à l'aide d'attaches métalliques, une plaque d'acier ou de laiton résistante sur laquelle figurent le nom de la substance prescrite contenue dans le dispositif d'exposition, l'activité de la substance prescrite et la date du relevé de l'activité;»

(2) L'alinéa 18.12(1)*e*)[1] du même règlement est abrogé et remplacé par ce qui suit:

«*e*) fixer solidement sur tout véhicule ou dans toute salle ou enceinte où le dispositif d'exposition est entreposé, une plaque résistante, facile à voir et lisible, portant ses nom, adresse et numéro de téléphone, ainsi qu'un avis indiquant qu'il doit être averti de toute situation d'urgence mettant en cause le dispositif d'exposition; et»

(3) Le passage de l'alinéa 18.12(1)*f*)[1] du même règlement qui précède le sous-alinéa (i) est abrogé et remplacé par ce qui suit:

[1] DORS/83-459, *Gazette du Canada* Partie II, 1983, p. 2313

operation of the exposure device and respecting the steps to be followed if"

(4) Subsection 18.12(2)[1] of the said Regulations is amended by deleting the word "and" at the end of paragraph (*b*) thereof and by revoking paragraph (*c*) thereof and substituting the following paragraphs therefor:

"(*c*) provide that person, through any arrangement that is satisfactory to that person, with

(i) all survey meters, tools, equipment or materials that he is required, under these Regulations, to possess before he operates the exposure device, and

(ii) a sufficient number of forms to record all information that he is required to record pursuant to paragraph 18.17(1)(*c*); and

(*d*) provide that person with all dosimeters that he is required, under these Regulations, to possess before he operates the exposure device."

8. (1) Subsection 18.13(2) of the said Regulations is revoked.

(2) Subsection 18.13(3) of the said Regulations is revoked and the following substituted therefor:

"(3) No licensee shall

(*a*) use any source capsule assembly or drive cable assembly in or with an exposure device unless it is approved by the Board or a designated officer and designed for that purpose; or

(*b*) modify any source capsule assembly, shielding, or lock in an exposure device except as approved by the Board or a designated officer."

9. (1) Subsection 18.14(1)[1] of the French version of the said Regulations is revoked and the following substituted therefor:

"18.14 (1) Le détenteur de permis doit limiter à 0,1 millisievert par semaine ou à 0,5 millisievert par année, la dose de rayonnement ionisant absorbée à la suite de l'utilisation ou de la possession du dispositif d'exposition visé par son permis, par une personne autre qu'un travailleur sous rayonnements ou qu'un employé du détenteur de permis ou d'une personne qui a retenu à contrat les services du détenteur de permis."

(2) Paragraph 18.14(2)(*b*)[1] of the French version of the said Regulations is revoked and the following substituted therefor:

"*b*) si un opérateur qualifié, un stagiaire ou un surveillant n'est pas en mesure d'interdire les entrées dans la zone visée à l'alinéa *a*), lorsqu'il utilise ou qu'il surveille l'utilisation du dispositif d'exposition, la mise en place d'un nombre suffisant de barrières autour de la zone ou l'affectation d'un nombre suffisant d'agents de sécurité près de l'enceinte de la zone, afin d'empêcher toute personne autre qu'un travailleur sous rayonnements de pénétrer dans la zone."

(3) Subsection 18.14(3)[1] of the said Regulations is revoked and the following substituted therefor:

«*f*) établir, à la satisfaction de la Commission ou d'un fonctionnaire désigné, des directives écrites concernant l'utilisation normale et sûre du dispositif d'exposition, ainsi que les mesures à suivre si»

(4) Le paragraphe 18.12(2)[1] du même règlement est modifié par suppression du mot «et» à la fin de l'alinéa *b*) et par abrogation de l'alinéa *c*) et son remplacement par ce qui suit:

«*c*) fournir à ladite personne, par des dispositions que celle-ci juge satisfaisantes,

(i) les radiamètres, les outils, l'équipement ou les matériaux qu'elle est tenue d'avoir, en vertu du présent règlement, avant de pouvoir utiliser le dispositif d'exposition, et

(ii) un nombre suffisant de formules pour enregistrer les renseignements exigés à l'alinéa 18.17(1)*c*); et

d) fournir à ladite personne les dosimètres qu'elle est tenue d'avoir, en vertu du présent règlement, avant de pouvoir utiliser le dispositif d'exposition.»

8. (1) Le paragraphe 18.13(2) du même règlement est abrogé.

(2) Les alinéas 18.13(3)*a*) et *b*)[1] du même règlement sont abrogés et remplacés par ce qui suit:

«*a*) d'utiliser une fixation de la source ou un mécanisme de commande par le câble dans ou avec le dispositif d'exposition, à moins que la fixation ou le mécanisme ne soit conçu à cette fin et approuvé par la Commission ou un fonctionnaire désigné; ou

b) de modifier, à l'intérieur du dispositif d'exposition, une fixation, un blindage ou un mécanisme de verrouillage de la source sans l'approbation de la Commission ou d'un fonctionnaire désigné.»

9. (1) Le paragraphe 18.14(1)[1] de la version française du même règlement est abrogé et remplacé par ce qui suit:

«18.14 (1) Le détenteur de permis doit limiter à 0,1 millisievert par semaine ou à 0,5 millisievert par année, la dose de rayonnement ionisant absorbée à la suite de l'utilisation ou de la possession du dispositif d'exposition visé par son permis, par une personne autre qu'un travailleur sous rayonnements ou qu'un employé du détenteur de permis ou d'une personne qui a retenu à contrat les services du détenteur de permis.»

(2) L'alinéa 18.14(2)*b*)[1] de la version française du même règlement est abrogé et remplacé par ce qui suit:

«*b*) si un opérateur qualifié, un stagiaire ou un surveillant n'est pas en mesure d'interdire les entrées dans la zone visée à l'alinéa *a*), lorsqu'il utilise ou qu'il surveille l'utilisation du dispositif d'exposition, la mise en place d'un nombre suffisant de barrières autour de la zone ou l'affectation d'un nombre suffisant d'agents de sécurité près de l'enceinte de la zone, afin d'empêcher toute personne autre qu'un travailleur sous rayonnements de pénétrer dans la zone.»

(3) Le paragraphe 18.14(3)[1] du même règlement est abrogé et remplacé par ce qui suit:

[1] SOR/83-459, 1983 *Canada Gazette* Part II, p. 2313

[1] DORS/83-459 *Gazette du Canada* Partie II, 1983, p. 2313

"(3) Where an exposure device is operated by a qualified operator or trainee on the premises of the licensee or of a person with whom the licensee has a contract for the services of the licensee and the licensee is unable to demonstrate to the satisfaction of the Board or a designated officer that the measures taken pursuant to subsection (2) are sufficient to limit the dose of ionizing radiation in accordance with subsection (1), the dose rate from the exposure device shall not exceed 2.5 microsieverts per hour measured at the perimeter of the area within which the movement of persons can be controlled by the qualified operator or by the trainee and the trainee supervisor."

10. (1) All that portion of paragraph 18.15(1)(*b*)[1] of the said Regulations preceding clause (B) thereof is revoked and the following substituted therefor:

"(*b*) he has

(i) in his possession or immediately available to him a copy of the written instructions prepared in respect of the exposure device pursuant to paragraph 18.12(1)(*f*), and

(ii) in his possession a properly functioning gamma radiation survey meter that

(A) is suitable for measuring gamma radiation emitted by the source capsule in the range from 20 microsieverts to 100 millisieverts per hour with a margin of error of no more than 20 per cent of the true dose rate,"

(2) All that portion of paragraph 18.15(1)(*c*)[1] of the said Regulations preceding subparagraph (i) thereof is revoked and the following substituted therefor:

"(*c*) where the exposure device is operated with a source guide tube, he has in his possession or immediately available to him the following, namely,"

11. Section 18.16[1] of the French version of the said Regulations is revoked and the following substituted therefor:

"18.16 (1) Le surveillant ne peut autoriser un stagiaire à utiliser un dispositif d'exposition que s'il est convaincu que:

a) le stagiaire connaît le mode d'emploi du dispositif d'exposition au point de pouvoir utiliser le dispositif d'exposition sans danger;

b) les dispositions de l'article 18.15 n'interdisent pas au stagiaire d'utiliser le dispositif d'exposition; et

c) l'utilisation du dispositif d'exposition par le stagiaire ne mettra pas en danger la santé ou la sécurité de d'autres personnes.

(2) Le surveillant qui autorise un stagiaire à utiliser un dispositif d'exposition doit assurer une obervation visuelle et une surveillance constantes du stagiaire pendant l'utilisation du dispositif d'exposition; si le stagiaire enfreint une disposition du présent règlement pendant cette utilisation, le surveillant doit immédiatement lui enlever le dispositif ou l'empêcher de continuer à l'utiliser.

(3) Le surveillant doit signaler sur-le-champ au détenteur de permis:

[1] SOR/83-459, 1983 *Canada Gazette* Part II, p. 2313

«18.14 (3) Lorsqu'un opérateur qualifié ou un stagiaire utilise un dispositif d'exposition dans les locaux du détenteur de permis ou d'une personne qui a retenu à contrat les services du détenteur de permis, et que le détenteur de permis ne peut pas prouver à la satisfaction de la Commission ou d'un fonctionnaire désigné que les mesures prises conformément au paragraphe (2) sont suffisantes pour limiter la dose de rayonnement ionisant au niveau prévu au paragraphe (1), le taux de dose provenant du dispositif d'exposition ne doit pas dépasser 2,5 microsieverts par heure autour de la zone où les mouvements de personnes peuvent être contrôlés par l'opérateur qualifié ou par le stagiaire et son surveillant.»

10. (1) Le passage de l'alinéa 18.15(1)*b*)[1] du même règlement qui précède la division (B) est abrogé et remplacé par ce qui suit:

«*b*) de:

(i) posséder ou pouvoir se procurer immédiatement un exemplaire des directives écrites établies à l'égard du dispositif d'exposition conformément à l'alinéa 18.12(1)*f*), et

(ii) posséder un gammamètre en bon état qui

(A) peut mesurer le rayonnement gamma émis par une source entre 20 microsieverts et 100 millisieverts par heure, compte tenu d'une marge d'erreur de 20 pour cent du taux véritable de la dose absorbée,»

(2) Le passage de l'alinéa 18.15(1)*c*)[1] du même règlement qui précède le sous-alinéa (i) est abrogé et remplacé par ce qui suit:

«*c*) de posséder ou de pouvoir se procurer immédiatement, lorsque le dispositif d'exposition est utilisé avec un tube de guidage de la source:»

11. L'article 18.16[1] de la version française du même règlement est abrogé et remplacé par ce qui suit:

«18.16 (1) Le surveillant ne peut autoriser un stagiaire à utiliser un dispositif d'exposition que s'il est convaincu que:

a) le stagiaire connaît le mode d'emploi du dispositif d'exposition au point de pouvoir utiliser le dispostif d'exposition sans danger;

b) les dispositions de l'article 18.15 n'interdisent pas au stagiaire d'utilser le dispositif d'exposition; et

c) l'utilisation du dispositif d'exposition par le stagiaire ne mettra pas en danger la santé ou la sécurité de d'autres personnes.

(2) Le surveillant qui autorise un stagiaire à utiliser un dispositif d'exposition doit assurer une observation visuelle et une surveillance constantes du stagiaire pendant l'utilisation du dispositif d'exposition; si le stagiaire enfreint une disposition du présent règlement pendant cette utilisation, le surveillant doit immédiatement lui enlever le dispositif ou l'empêcher de continuer à l'utiliser.

(3) Le surveillant doit signaler sur-le-champ au détenteur de permis:

[1] DORS/83-459, *Gazette du Canada* Partie II, 1983, p. 2213

a) tout incident visé à l'alinéa 18.12(1)*f*), au paragraphe 18.18(1) ou à l'article 18.19 qui met en cause un stagiaire qu'il surveille; et

b) toute infraction au présent règlement commise par un stagiaire qu'il surveille.

(4) Seul le surveillant peut assurer la surveillance d'un stagiaire qui utilise un dispositif d'exposition."

12. (1) Paragraphs 18.17(1)(*a*)[1] and (*b*)[1] of the French version of the said Regulations are revoked and the following substituted therefor:

"*a*) vérifier, à l'aide d'un radiamètre, que la source a réintégré sa position blindée appropriée dans le dispositif d'exposition après chaque utilisation du dispositif d'exposition;

b) prendre toutes les précautions raisonnables pour s'assurer que la dose de rayonnement ionisant absorbée à la suite d'une telle utilisation par une personne autre qu'un travailleur sous rayonnements ou qu'un employé du détenteur de permis ou d'une personne qui a retenu à contrat les services du détenteur de permis, se limite à 0,1 millisievert par semaine et à 0,5 millisievert par année;"

(2) Subsection 18.17(1)[1] of the said Regulations is further amended by deleting the word "and" at the end of paragraph (*c*) thereof and by revoking paragraph (*d*) thereof and substituting the following paragraphs therefor:

"(*d*) lock and securely store the exposure device at the end of each day of operation of the exposure device;

(*e*) lock the exposure device whenever the exposure device is not under his care and control; and

(*f*) secure the source capsule in the proper shielded position before moving the exposure device."

13. (1) Paragraph 18.20(1)(*b*) of the said Regulations is revoked.

(2) Subsection 18.20(2)[1] of the said Regulations is revoked and the following substituted therefor:

"(2) Every person who removes any prescribed substance from or inserts any prescribed substance into an exposure device shall measure the radiation levels and radiation exposure dosages during the course of and forthwith after the completion of the removal or insertion and submit the measurements to the licensee."

14. (1) Paragraph 18.22(1)(*a*)[1] of the said Regulations is revoked and the following substituted therefor:

"(*a*) subject to subsection (3), submit to the licensee at the end of each semi-monthly period all thermoluminescent and film dosimeters worn by him during the period;"

(2) Section 18.22[1] of the said Regulations is further amended by adding thereto the following subsection:

"(3) The Board or a designated officer may approve a monthly period for the submission referred to in paragraph (1)(*a*) where

[1] SOR/83-459, 1983 *Canada Gazette* Part II, p. 2313

a) tout incident visé à l'alinéa 18.12(1)*f*), au paragraphe 18.18(1) ou à l'article 18.19 qui met en cause un stagiaire qu'il surveille; et

b) toute infraction au présent règlement commise par un stagiaire qu'il surveille.

(4) Seul le surveillant peut assurer la surveillance d'un stagiaire qui utilise un dispositif d'exposition.»

12. (1) Les alinéas 18.17(1)*a*)[1] et *b*)[1] de la version française du même règlement sont abrogés et remplacés par ce qui suit:

«*a*) vérifier, à l'aide d'un radiamètre, que la source a réintégré sa position blindée appropriée dans le dispositif d'exposition après chaque utilisation du dispositif d'exposition;

b) prendre toutes les précautions raisonnables pour s'assurer que la dose de rayonnement ionisant absorbée à la suite d'une telle utilisation par une personne autre qu'un travailleur sous rayonnements ou qu'un employé du détenteur de permis ou d'une personne qui a retenu à contrat les services du détenteur de permis, se limite à 0,1 millisievert par semaine et à 0,5 millisievert par année;»

(2) Le paragraphe 18.17(1)[1] du même règlement est modifié par suppression du mot «et» à la fin de l'alinéa *c*) et par abrogation de l'alinéa *d*) et son remplacement par ce qui suit:

«*d*) verrouiller le dispositif d'exposition et l'entreposer en lieu sûr à la fin de chaque journée d'utilisation;

e) verrouiller le dispositif d'exposition dès que celui-ci n'est plus sous sa surveillance et son contrôle ou qu'il est déplacé; et

f) mettre la source dans la position blindée appropriée avant de déplacer le dispositif d'exposition.»

13. (1) L'alinéa 18.20(1)*b*) du même règlement est abrogé.

(2) Le paragraphe 18.20(2)[1] du même règlement est abrogé et remplacé par ce qui suit:

«(2) Quiconque enlève une substance prescrite d'un dispositif d'exposition ou y insère une telle substance doit mesurer les niveaux de rayonnement et les doses d'exposition aux rayonnements pendant et immédiatement après l'enlèvement ou l'insertion de la substance prescrite, et soumettre les relevés au détenteur de permis.»

14. (1) L'alinéa 18.22(1)*a*)[1] du même règlement est abrogé et remplacé par ce qui suit:

«*a*) sous réserve du paragraphe (3), remettre au détenteur de permis, à la fin de chaque quinzaine, les dosimètres thermoluminescents ou photographiques qu'elle a portés sur elle au cours de la période;»

(2) L'article 18.22[1] du même règlement est modifié par adjonction de ce qui suit:

«(3) La Commission ou un fonctionnaire désigné peut autoriser que la période prévue à l'alinéa (1)*a*) soit portée à un mois, si:

a) la personne autorisée par le détenteur de permis à utiliser ou à posséder le dispositif d'exposition ne le fait que

[1] DORS/83-459, *Gazette du Canada* Partie II, 1983, p. 2313

(*a*) the person permitted by the licensee to operate or possess the exposure device does so only in a room designed for the operation of an exposure device; and

(*b*) the licensee is and has been in compliance with subsection 19(1)."

15. (1) Paragraph 18.23(1)(*f*)[1] of the said Regulations is revoked and the following substituted therefor:

"(*f*) a record for each operator of the exposure device of the radiation dosages received by the operator as determined from thermoluminescent or film dosimeters and from direct reading dosimeters required to be carried or worn by the operator pursuant to these Regulations."

(2) Paragraph 18.23(2)(*b*)[1] of the said Regulations is revoked and the following substituted therefor:

"(*b*) provide a copy of those records to the Board on the written request of the Board or a designated officer."

(3) Paragraph 18.23(3)(*b*)[1] of the said Regulations is hereby revoked and the following substituted therefor:

"(*b*) deposit those records or a copy thereof with the Board on the written request of the Board or a designated officer."

16. Paragraph 25(*b*) of the said Regulations is revoked and the following substituted therefor:

"(*b*) in accordance with the written instructions of the Board or a designated officer."

EXPLANATORY NOTE

(This note is not part of the Regulations.)

These amendments

(*a*) correct inconsistencies in the French version;

(*b*) revise and clarify requirements respecting the use and possession of exposure devices in industrial radiography; and

(*c*) add the reference "designated officer" in certain sections.

dans une pièce conçue pour l'utilisation des dispositifs d'exposition; et

b) le détenteur de permis s'est toujours conformé et continue de se conformer au paragraphe 19(1).»

15. (1) L'alinéa 18.23(1)*f*)[1] du même règlement est abrogé et remplacé par ce qui suit:

«*f*) un registre, pour chaque opérateur, des relevés de toutes les doses de rayonnement reçues par l'opérateur selon le dosimètre thermoluminescent ou photographique et le dosimètre à lecture directe que l'opérateur doit transporter ou porter sur lui conformément au présent règlement.»

(2) L'alinéa 18.23(2)*b*)[1] du même règlement est abrogé et remplacé par ce qui suit:

«*b*) déposer un exemplaire de ces dossiers auprès de la Commission ou d'un fonctionnaire désigné, si l'un des deux lui en fait la demande par écrit.»

(3) L'alinéa 18.23(3)*b*)[1] du même règlement est abrogé et remplacé par ce qui suit:

«*b*) déposer lesdits dossiers ou un exemplaire de ceux-ci auprès de la Commission ou d'un fonctionnaire désigné, si l'un des deux lui en fait la demande par écrit.»

16. L'alinéa 25*b*) du même règlement est abrogé et remplacé par ce qui suit:

«*b*) selon les instructions écrites de la Commission ou d'un fonctionnaire désigné.»

NOTE EXPLICATIVE

(La présente note ne fait pas partie du règlement.)

Les modifications visent à:

a) rendre certains passages de la version française conformes à la version anglaise;

b) réviser et clarifier les exigences relatives à l'utilisation et à la possession des dispositifs d'exposition à des fins de radiographie industrielle;

c) ajouter un renvoi au «fonctionnaire désigné» dans certains articles.

[1] SOR/83-459, 1983 *Canada Gazette* Part II, p. 2313

[1] DORS/83-459, *Gazette du Canada* Partie II, 1983, p. 2313

QUEEN'S PRINTER FOR CANADA, OTTAWA, 1986

IMPRIMEUR DE LA REINE POUR LE CANADA, OTTAWA, 1986

Appendix B

Derivation of Minimum Source Requirement and Positional Accuracy

B.1 Source Strength Requirements

The dose rate due to a source of 10 Ci is given by the relationship;

$$E_r = \frac{Ko}{r^2} \qquad -(1)$$

where; r is the meter-source distance in cm
; Ko is a constant determined to be 3.77×10^4 (R/hr) Cm^2 from Figure 4.
; and E_r is the exposure rate in R/hr

With equation 1 it was calculated that the meter would have to be placed 73.4 cm from the source in order to achieve a calibrating field of 7 R/hr with a 10 Ci source.

For a smaller source strength of 1 Ci, Ko would decrease by a factor of 10 to 3.77×10^3 (R/hr) Cm^2.

Again from equation 1 it was calculated that a meter would have to be placed 23 cm from the source in order to achieve a 7 R/hr calibrating field with a 1 Ci source.

There is, however, a limit to how close a meter can be placed to a source. This is because for close distances the point source assumption in the $1/r^2$ relationship is not valid. Reference 5 (ANSI) recommends that the source to detector distance be at least seven times the larger dimension of the radiation source, or the active volume of the meter to ensure the inverse square law relationship (or point source assumption) holds. Source diameter or ionization chamber diameters for a survey meter vary with different manufacturers. From a review of some typical specs, however, an average minimum diameter of about 3.0 cm (just over an inch) has been determined. Seven times this measurement is 21 cm. The calculations given above show that for a 1 Ci (37.0 GBq) source a minimum source to meter distance of 23 cm is required. Therefore, the $1/r^2$ relationship would hold. A smaller source strength however would not be adequate.

B.2 Position Accuracy Requirements

The slope of the curve given in Figure 4 is the derivative of Equation 1. For a 1 curie source the slope would be:

$$\frac{d E_r}{dr} = \frac{-2 \times 3.77 \times 10^3}{r^3} \qquad \text{(R/hr)/cm} \qquad -(2)$$

From simple error analysis, an uncertainty in, r, would result in an uncertainty in the exposure rate, E_r, directly proportional to the slope of the curve (equation 2). At the

minimum required distance of 23 cm (Section 2.4.2), the slope calculated from equation 2 is .62 R/hr/cm.

Thus for an uncertainty in measurement of say ± .5 cm an uncertainty in the calibration field would be ± .31 R/hr.

In terms of the required field 7 R/hr this represents a ± 4.4% uncertainty. As will be discussed in 2.5 a more acceptable uncertainty would be ± 2.0% or a measurement uncertainty of about ± 3 mm.

Of course this requirement could be relaxed at larger source to meter distances, however, a ± 3 mm precision should be obtainable without too much difficulty over all distances with adequate equipment.

Appendix C

Excerpts of 10 CFR 34

Licenses for Radiography

and Radiation Safety

PART 34

LICENSES FOR RADIOGRAPHY AND RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHIC OPERATIONS

Sec.

34.1 Purpose and scope.
34.2 Definitions.
34.3 Applications for specific licenses.
34.8 Information collection requirements: OMB approval.

Subpart A—Specific Licensing Requirements

34.11 Issuance of specific licenses for use of sealed sources in radiography.

Subpart B—Radiation Safety Requirements

EQUIPMENT CONTROL

34.21 Limit on levels of radiation for radiographic exposure devices and storage containers.
34.22 Locking of radiographic exposure devices and storage containers.
34.23 Storage precautions.
34.24 Radiation survey instruments.
34.25 Leak testing, repair, tagging, opening, modification and replacement of sealed sources.
34.26 Quarterly inventory.
34.27 Utilization logs.
34.28 Inspection and maintenance of radiographic exposure devices and storage containers.
34.29 Permanent radiographic installations.

PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANT

34.31 Training.
34.32 Operating and emergency procedures.
34.33 Personnel monitoring.

PRECAUTIONARY PROCEDURES IN RADIOGRAPHIC OPERATIONS

34.41 Security.
34.42 Posting.
34.43 Radiation surveys and survey records.
34.44 Supervision of radiographers' assistants

EXEMPTIONS

34.51 Applications for exemptions.
Appendix A.

51 FR 21736

Authority: Secs. 81, 161, 182, 183, 68 Stat. 935, 948, 953, 954, as amended (42 U.S.C. 2111, 2201, 2232, 2233); sec. 201, 88 Stat. 1242, as amended (42 U.S.C. 5841).

Section 34.32 also issued under sec. 208, 88 Stat. 1246 (42 U.S.C. 5848).

For the purposes of sec. 223, 68 Stat. 958, as amended (42 U.S.C. 2273); §§ 34.22, 34.23, 34.24, 34.25 (a), (b), and (d), 34.28, 34.29, 34.31 (a) and (b), 34.32, 34.33 (a), (c), and (d), 34.41, 34.42, 34.43(a), (b), and (c), and 34.44 are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C. 2201(b)); and §§ 34.11(d), 34.25 (c) and (d), 34.28, 34.27, 34.28(b), 34.29(c), 34.31(c), 34.33 (b) and (e), and 34.43(d) are issued under sec. 161o, 68 Stat. 950, as amended (42 U.S.C. 2201(o)). §§ 34.2, 34.11, 34.22, 34.28, 34.29, 34.31, 34.32, 34.33, 34.43, 34.44, 34.51, and Appendix A—[Amended]

§ 34.1 Purpose and scope.

This part prescribes requirements for the issuance of licenses for the use of sealed sources containing byproduct material and radiation safety requirements for persons using such sealed sources in radiography. The provisions and requirements of this part are in addition to, and not in substitution for, other requirements of this chapter. In particular, the provisions of Part 30 of this chapter apply to applications and licenses subject to this part. Nothing in this part shall apply to uses of byproduct material for medical diagnosis or therapy.

30 FR 8185

§ 34.2 Definitions.

As used in this part:

"Permanent radiographic installation" means a shielded installation or structure designed or intended for radiography and in which radiography is regularly performed.

"Radiographer" means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of the Commission's regulations and the conditions of the license;

"Radiographer's assistant" means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or radiation survey instruments in radiography;

"Radiographic exposure device" means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure;

"Radiography" means the examination of the structure of materials by nondestructive methods, utilizing sealed sources of byproduct materials;

"Sealed source" means any byproduct material that is encased in a capsule designed to prevent leakage or escape of the byproduct material;

"Storage area" means any location, facility, or vehicle which is used to store, to transport, or to secure a radiographic exposure device, a storage container, or a sealed source when it is not in use and which is locked or has a physical barrier to prevent accidental exposure, tampering with, or unauthorized removal of the device, container, or source.

"Storage container" means a device in which sealed sources are transported or stored.

"Source changer" means a device designed and used for replacement of sealed sources in radiographic exposure devices, including those also used for transporting and storage of sealed sources.

51 FR 21736

§ 34.3 Applications for specific licenses.

A person may file an application for specific license for use of sealed sources in radiography in duplicate on NRC Form 313, "Application for Material License," in accordance with the provisions of § 30.32 of this chapter.

48 FR 27923

§ 34.8 Information collection requirements: OMB approval.

(a) The Nuclear Regulatory Commission has submitted the information collection requirements contained in this part to the Office of Management and Budget (OMB) for approval as required by the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). OMB has approved the information collection requirements contained in this part under control number 3150-0007.

(b) The approved information collection requirements contained in this part appear in §§ 34.11, 34.24, 34.25, 34.26, 34.27, 34.28, 34.29, 34.31, 34.32, 34.33, and 34.43.

49 FR 19423

(c) This part contains information collection requirements in addition to those approved under the control number specified in paragraph (a) of this section. These information collection requirements and the control numbers under which they are approved are as follows:

(1) In § 34.3, Form NRC-313R is approved under control number 3150-0023.

Subpart A—Specific Licensing Requirements

§ 34.11 Issuance of specific licenses for use of sealed sources in radiography.

An application for a specific license for use of sealed sources in radiography will be approved if:

(a) The applicant satisfies the general requirements specified in §30.33 of this chapter;

(b) The applicant will have an adequate program for training radiographers and radiographers' assistants and submits to the Commission a schedule or description of such program which specifies the:

(1) Initial training;

(2) Periodic training;

(3) On-the-job training;

(4) Means to be used by the licensee to determine the radiographer's knowledge and understanding of and ability to comply with Commission regulations and licensing requirements, and the operating and emergency procedures of the applicant; and

(5) Means to be used by the licensee to determine the radiographer's assistant's knowledge and understanding of and ability to comply with the operating and emergency procedures of the applicant;

(c) The applicant has established and submits to the Commission satisfactory written operating and emergency procedures as described in §34.32;

(d) The applicant has established and submits to the Commission a description of its inspection program adequate to ensure that its radiographers and radiographers' assistants follow the Commission's regulatory requirements and the applicant's operating and emergency procedures. The inspection program must:

(1) Include observation of the performance of each radiographer and radiographer's assistant during an actual radiographic operation at intervals not to exceed three months;

(2) Provide that, if a radiographer or a radiographer's assistant has not participated in a radiographic operation for more than three months since the last inspection, that individual's performance must be observed and recorded the next time the individual participates in a radiographic operation; and

(3) Include the retention of inspection records on the performance of radiographers or radiographers' assistants for three years.

(e) The applicant submits a description of its over-all organizational structure pertaining to the radiography program, including specified delegations of authority and responsibility for operation of the program; and

(f) The applicant who desires to conduct his own leak tests has established adequate procedures to be followed in leak testing sealed sources, for possible leakage and contamination and submits to the Commission a description of such procedures including:

(1) Instrumentation to be used,

(2) Method of performing test, e.g., points on equipment to be smeared and method of taking smear, and

(3) Pertinent experience of the person who will perform the test.

Subpart B—Radiation Safety Requirements

EQUIPMENT CONTROL

§ 34.21 Limits on levels of radiation for radiographic exposure devices and storage containers.

Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device. Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for sealed sources or for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. The radiation levels specified are with the sealed source in the shielded (i.e., "off") position.

§ 34.22 Locking of radiographic exposure devices, storage containers, and source changers.

(a) Each radiographic exposure device shall have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. The exposure device or its container shall be kept locked when not under the direct surveillance of a radiographer or a radiographer's assistant or as otherwise may be authorized in § 34.41. In addition, during radiographic operations the sealed source assembly shall be secured in the shielded position each time the source is returned to that position.

(b) Each sealed source storage container and source changer shall have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. Storage containers and source changers shall be kept locked when containing sealed sources except when under the direct surveillance of a radiographer or a radiographer's assistant.

§ 34.23 Storage precautions.

Locked radiographic exposure devices and storage containers shall be physically secured to prevent tampering or removal by unauthorized personnel.

§ 34.24 Radiation survey instruments.

The licensee shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this part and Part 20 of this chapter.

Each radiation survey instrument shall be calibrated at intervals not to exceed three months and after each instrument servicing and a record shall be maintained of the results of each instrument calibration and date thereof for two years after the date of calibration.

Instrumentation required by this section shall have a range such that two milliroentgens per hour through one roentgen per hour can be measured.

§ 34.25 Leak testing, repair, tagging, opening, modification and replacement of sealed sources.

(a) The replacement of any sealed source fastened to or contained in a radiographic exposure device and leak testing, repair, tagging, opening or any other modification of any sealed source shall be performed only by persons specifically authorized by the Commission to do so.

(b) Each sealed source shall be tested for leakage at intervals not to exceed 6 months. In the absence of a certificate from a transferor that a test has been made within the 6 months prior to the transfer, the sealed source shall not be put into use until tested.

(c) The leak test shall be capable of detecting the presence of 0.005 microcurie of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography licensee would be to test at the nearest accessible point to the sealed source storage position, or other appropriate measuring point, by a procedure to be approved pursuant to §34.11(f).

Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Commission for six months after the next required leak test is performed or until the sealed source is transferred or disposed of.

(d) Any test conducted pursuant to paragraphs (b) and (c) of this section which reveals the presence of 0.005 microcurie or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with Commission regulations. A report shall be filed, within 5 days of the test, with the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, describing the equipment involved, the test results, and the corrective action taken. A copy of such report shall be sent to the Director of the appropriate Nuclear Regulatory Commission's Inspection and Enforcement Regional Office listed in Appendix D of Part 20 of this chapter "Standards for Protection Against Radiation."

(e) A sealed source which is not fastened to or contained in a radiographic exposure device shall have permanently attached to it a durable tag at least one (1) inch square bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions: "Danger–Radioactive Material–Do Not Handle–Notify Civil Authorities if Found."

§ 34.26 Quarterly inventory.

Each licensee shall conduct a quarterly physical inventory to account for all sealed sources received and possessed under his license. The records of the inventories shall be maintained for two years from the date of the inventory for inspection by the Commission, and shall include the quantities and kinds of byproduct material, location of sealed sources, and the date of the inventory.

§ 34.27 Utilization logs.

Each licensee shall maintain current logs, which shall be kept available for two years from the date of the recorded event, for inspection by the Commission, at the address specified in the license, showing for each sealed source the following information:

(a) A description (or make and model number) of the radiographic exposure device or storage container in which the sealed source is located;

(b) The identity of the radiographer to whom assigned; and

(c) The plant or site where used and dates of use.

§ 34.28 Inspection and maintenance of radiographic exposure devices, storage containers, and source changers.

(a) The licensee shall check for obvious defects in radiographic exposure devices, storage containers, and source changers prior to use each day the equipment is used.

(b) The licensee shall conduct a program for inspection and maintenance of radiographic exposure devices, storage containers, and source changers at intervals not to exceed three months or prior to the first use thereafter to assure proper functioning of components important to safety. Records of these inspections and maintenance shall be kept for two years.

§ 34.29 Permanent radiographic installations.

(a) Permanent radiographic installations having high radiation area entrance controls of the types described in § 20.203(c) (2)(ii), (2)(iii), or (4) shall also meet the following special requirement.

(b) Each entrance that is used for personnel access to the high radiation area in a permanent radiographic installation to which this section applies shall have both visible and audible warning signals to warn of the presence of radiation. The visible signal shall be actuated by radiation whenever the source is exposed. The audible signal shall be actuated when an attempt is made to enter the installation while the source is exposed.

(c) The alarm system shall be tested at intervals not to exceed three months or prior to the first use thereafter of the source in the installation. Records of the tests shall be kept for two years.

PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS

§ 34.31 Training.

(a) The licensee shall not permit any individual to act as a radiographer until such individual:

(1) Has been instructed in the subjects outlined in Appendix A of this part;

(2) Has received copies of and instruction in NRC regulations contained in this part and in the applicable sections of Parts 19 and 20 of this chapter, NRC license(s) under which the radiographer will perform radiography, and the licensee's operating and emergency procedures;

(3) Has demonstrated competence to use the licensee's radiographic exposure devices, sealed sources, related handling tools, and survey instruments; and

(4) Has demonstrated understanding of the instructions in this paragraph (a) by successful completion of a written test and a field examination on the subjects covered.

(b) The licensee shall not permit any individual to act as a radiographer's assistant until such individual:

(1) Has received copies of and instruction in the licensee's operating and emergency procedures;

(2) Has demonstrated competence to use, under the personal supervision of the radiographer, the radiographic exposure devices, sealed sources, related handling tools, and radiation survey instruments that the assistant will use; and

(3) Has demonstrated understanding of the instructions in this paragraph (b) by successfully completing a written or oral test and a field examination on the subjects covered.

(c) Records of the above training, including copies of written tests and dates of oral tests and field examinations, shall be maintained for three years.

(c) The leak test shall be capable of detecting the presence of 0.005 microcurie of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography licensee would be to test at the nearest accessible point to the sealed source storage position, or other appropriate measuring point, by a procedure to be approved pursuant to §34.11(f). [30 FR 8185]

Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Commission for six months after the next required leak test is performed or until the sealed source is transferred or disposed of. [41 FR 19380]

(d) Any test conducted pursuant to paragraphs (b) and (c) of this section which reveals the presence of 0.005 microcurie or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with Commission regulations. A report shall be filed, within 5 days of the test, with the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, describing the equipment involved, the test results, and the corrective action taken. A copy of such report shall be sent to the Director of the appropriate Nuclear Regulatory Commission's Inspection and Enforcement Regional Office listed in Appendix D of Part 20 of this chapter "Standards for Protection Against Radiation." [30 FR 8185]

(e) A sealed source which is not fastened to or contained in a radiographic exposure device shall have permanently attached to it a durable tag at least one (1) inch square bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions: "Danger—Radioactive Material—Do Not Handle—Notify Civil Authorities if Found."

§ 34.26 Quarterly inventory.

Each licensee shall conduct a quarterly physical inventory to account for all sealed sources received and possessed under his license. The records of the inventories shall be maintained for two years from the date of the inventory for inspection by the Commission, and shall include the quantities and kinds of byproduct material, location of sealed sources, and the date of the inventory. [41 FR 19380]

§ 34.27 Utilization logs.

Each licensee shall maintain current logs, which shall be kept available for two years from the date of the recorded event, for inspection by the Commission, at the address specified in the license, showing for each sealed source the following information:

(a) A description (or make and model number) of the radiographic exposure device or storage container in which the sealed source is located; [30 FR 8185]

(b) The identity of the radiographer to whom assigned; and

(c) The plant or site where used and dates of use.

§ 34.28 Inspection and maintenance of radiographic exposure devices, storage containers, and source changers. [41 FR 55665]

(a) The licensee shall check for obvious defects in radiographic exposure devices, storage containers, and source changers prior to use each day the equipment is used.

(b) The licensee shall conduct a program for inspection and maintenance of radiographic exposure devices, storage containers, and source changers at intervals not to exceed three months or prior to the first use thereafter to assure proper functioning of components important to safety. Records of these inspections and maintenance shall be kept for two years.

§ 34.29 Permanent radiographic installations.

(a) Permanent radiographic installations having high radiation area entrance controls of the types described in § 20.203(c) (2)(ii), (2)(iii), or (4) shall also meet the following special requirement.

(b) Each entrance that is used for personnel access to the high radiation area in a permanent radiographic installation to which this section applies shall have both visible and audible warning signals to warn of the presence of radiation. The visible signal shall be actuated by radiation whenever the source is exposed. The audible signal shall be actuated when an attempt is made to enter the installation while the source is exposed.

(c) The alarm system shall be tested at intervals not to exceed three months or prior to the first use thereafter of the source in the installation. Records of the tests shall be kept for two years.

PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS

§ 34.31 Training.

(a) The licensee shall not permit any individual to act as a radiographer until such individual:

(1) Has been instructed in the subjects outlined in Appendix A of this part;

(2) Has received copies of and instruction in NRC regulations contained in this part and in the applicable sections of Parts 19 and 20 of this chapter, NRC license(s) under which the radiographer will perform radiography, and the licensee's operating and emergency procedures;

(3) Has demonstrated competence to use the licensee's radiographic exposure devices, sealed sources, related handling tools, and survey instruments; and

(4) Has demonstrated understanding of the instructions in this paragraph (a) by successful completion of a written test and a field examination on the subjects covered. [41 FR 55665]

(b) The licensee shall not permit any individual to act as a radiographer's assistant until such individual:

(1) Has received copies of and instruction in the licensee's operating and emergency procedures;

(2) Has demonstrated competence to use, under the personal supervision of the radiographer, the radiographic exposure devices, sealed sources, related handling tools, and radiation survey instruments that the assistant will use; and

(3) Has demonstrated understanding of the instructions in this paragraph (b) by successfully completing a written or oral test and a field examination on the subjects covered.

(c) Records of the above training, including copies of written tests and dates of oral tests and field examinations, shall be maintained for three years.